TISA (Time-Space Averaging) Update

D. Doelling

NASA LaRC

TISA Team:

R. Bhatt, D. Morstad, C. Nguyen, M. Nordeen,
R. Parish, R. Raju, M. Sun

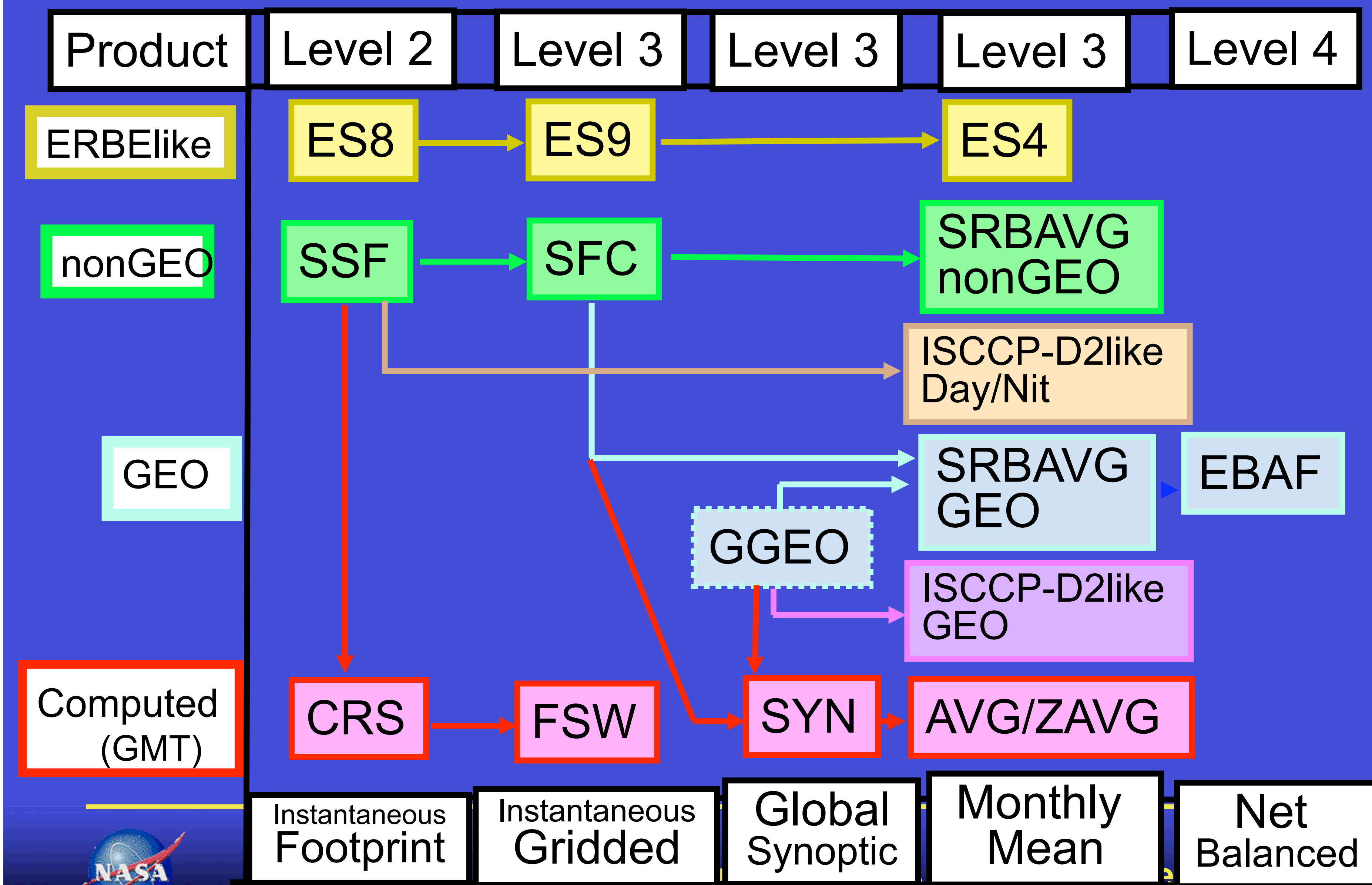
SSAI

12th CERES-II Science Team Meeting
Ft Collins, Collins, VA, November 3-5, 2009

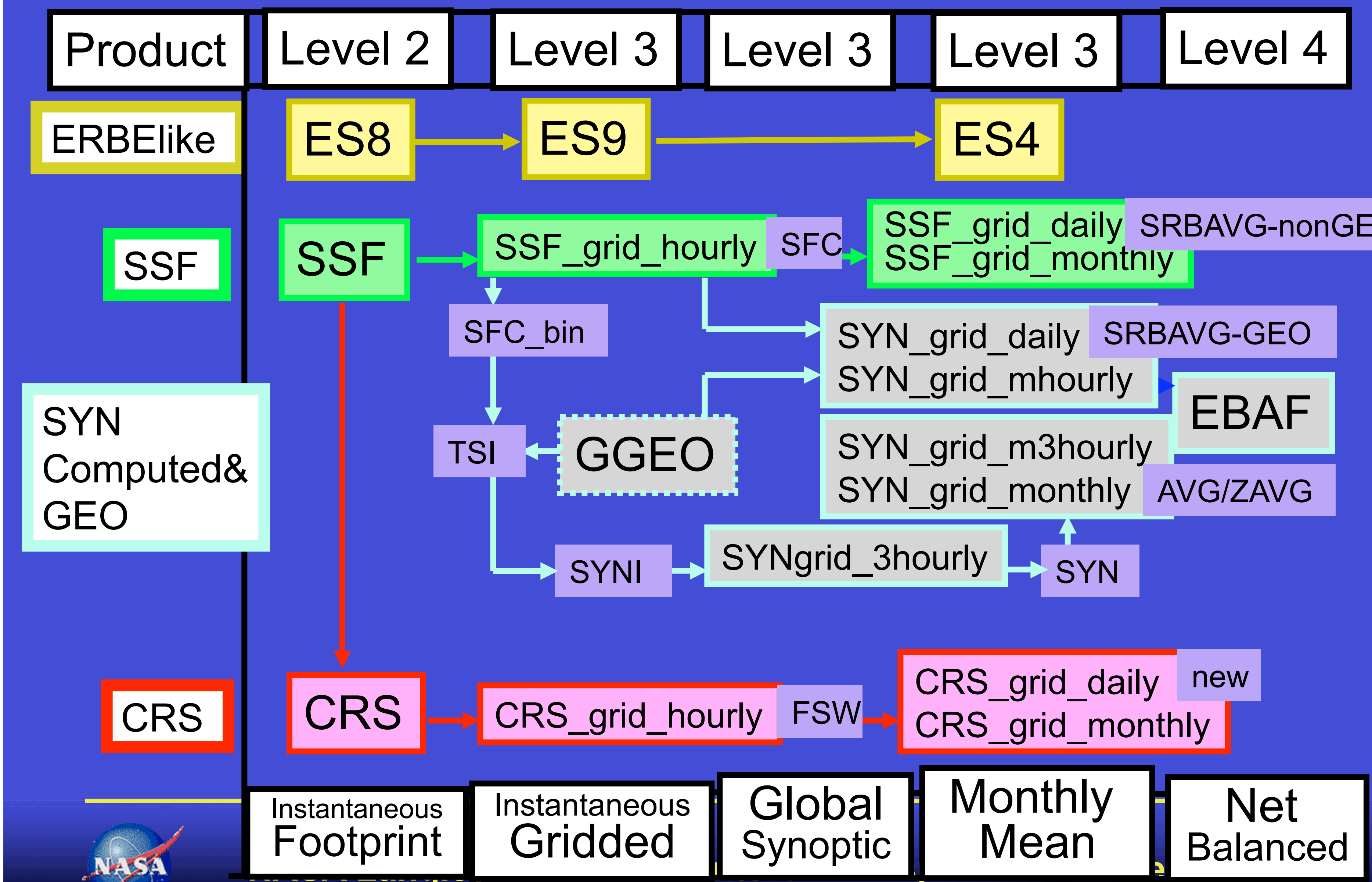
Outline

- New CERES file naming convention and flowcharts
- Introduction to CERES monthly averaged products
- SSF-grid-monthly-lite 2.5 dataset
- CERES Ed3 ordering tool
- MTSAT calibration update
- ISCCP-D2like Ed2 products
- TISA Ed3 goals, product status and upcoming deliveries

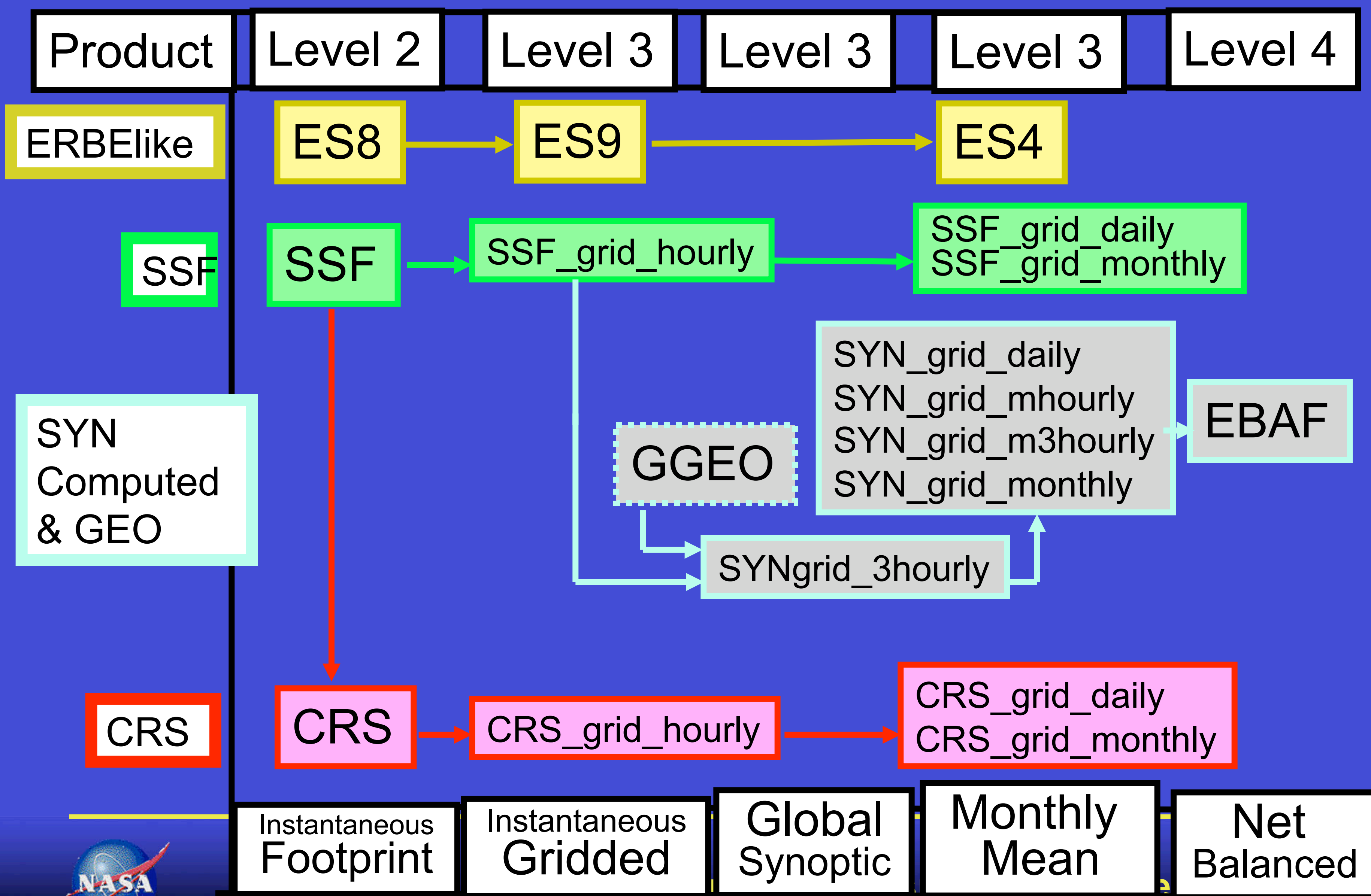
CERES Ed2 Product file name convention



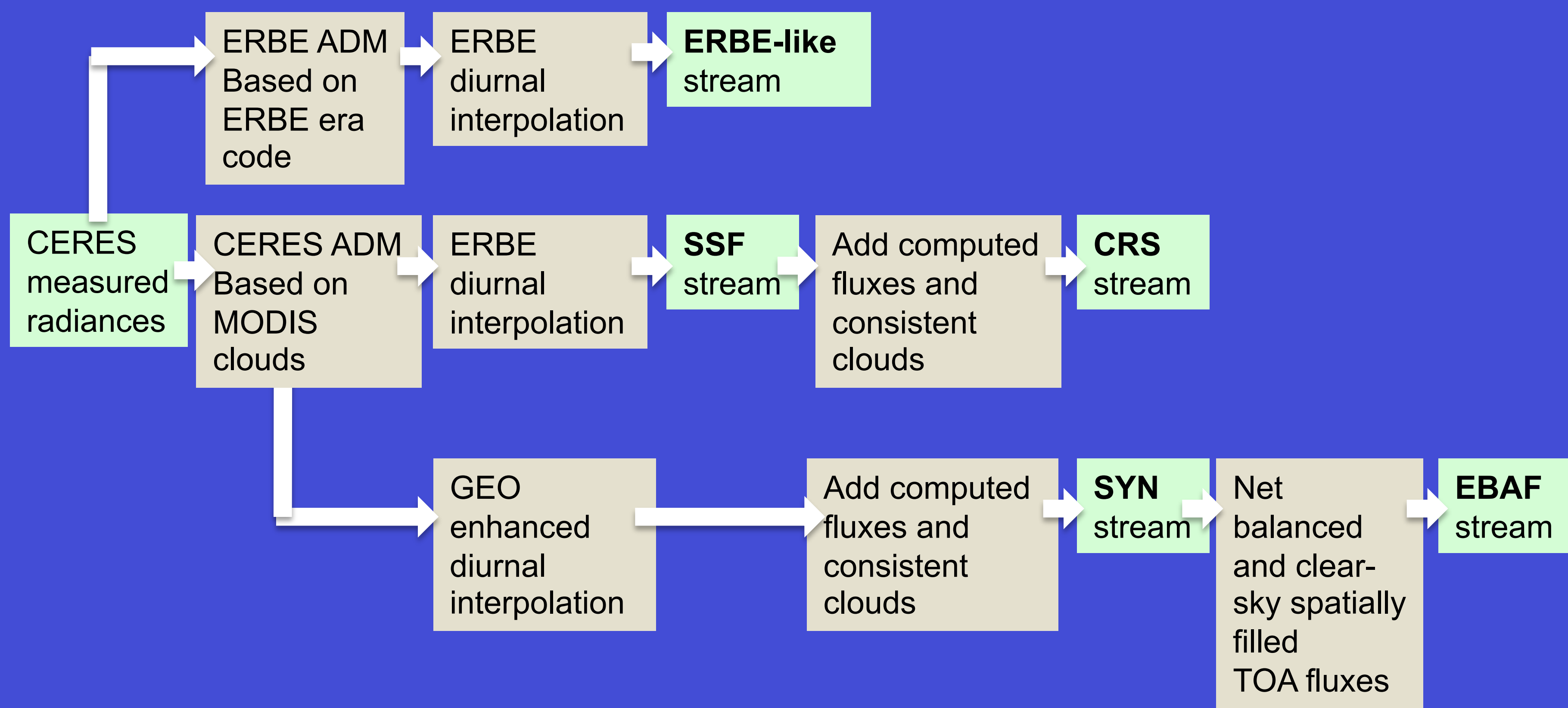
CERES Ed3 Product file name convention



CERES Ed3 Product file name convention

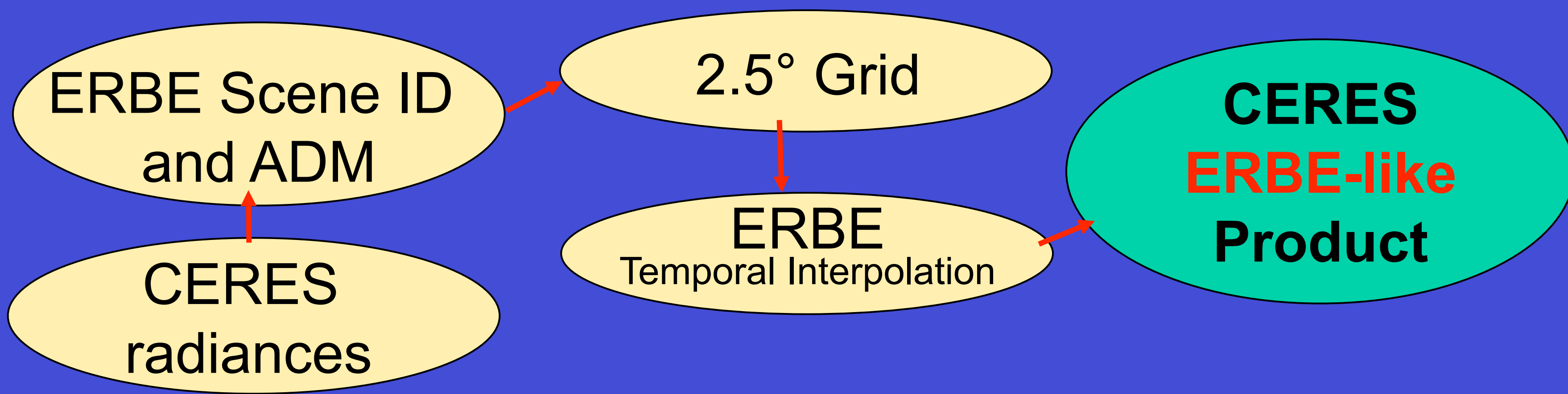


CERES Ed3 product flowchart



ERBE-like Product

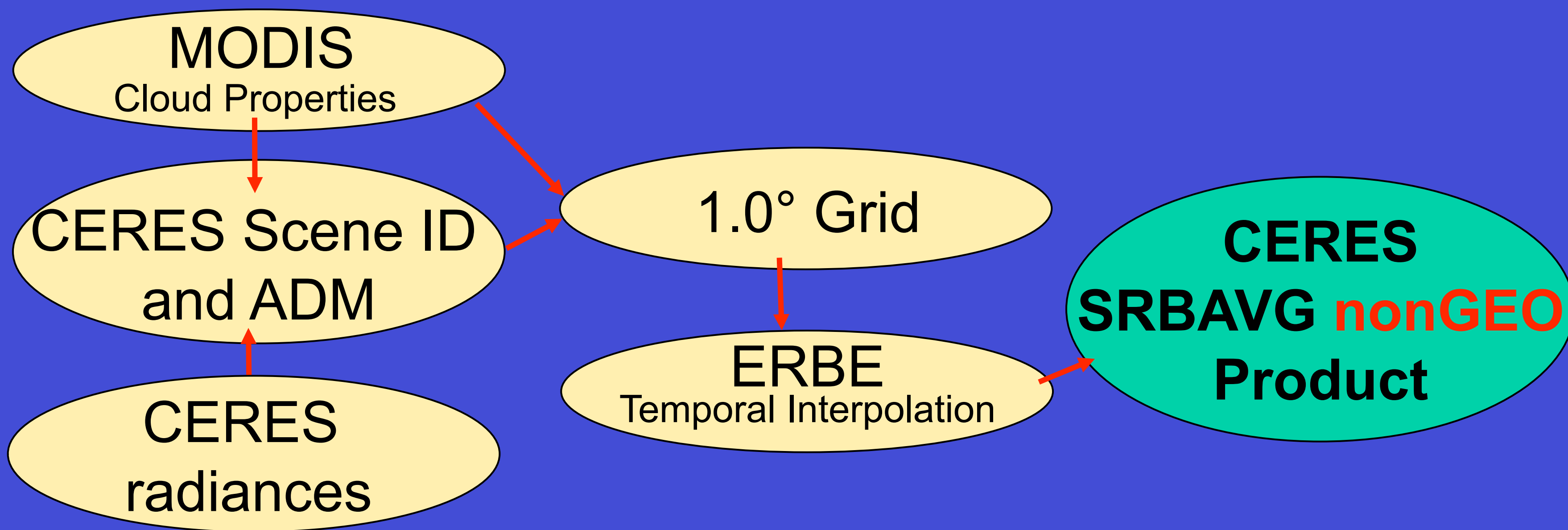
- Product Features:
  - – Based on ERBE algorithms and in the same format (ES-4 & ES-9) as the original ERBE scanner dataset (1985-1989)



- Appropriate Usage:
  - – To compare with historical ERBE (1985-1989) fluxes to ensure that flux differences are not associated with CERES algorithm improvements

SRBAVG nonGEO Product

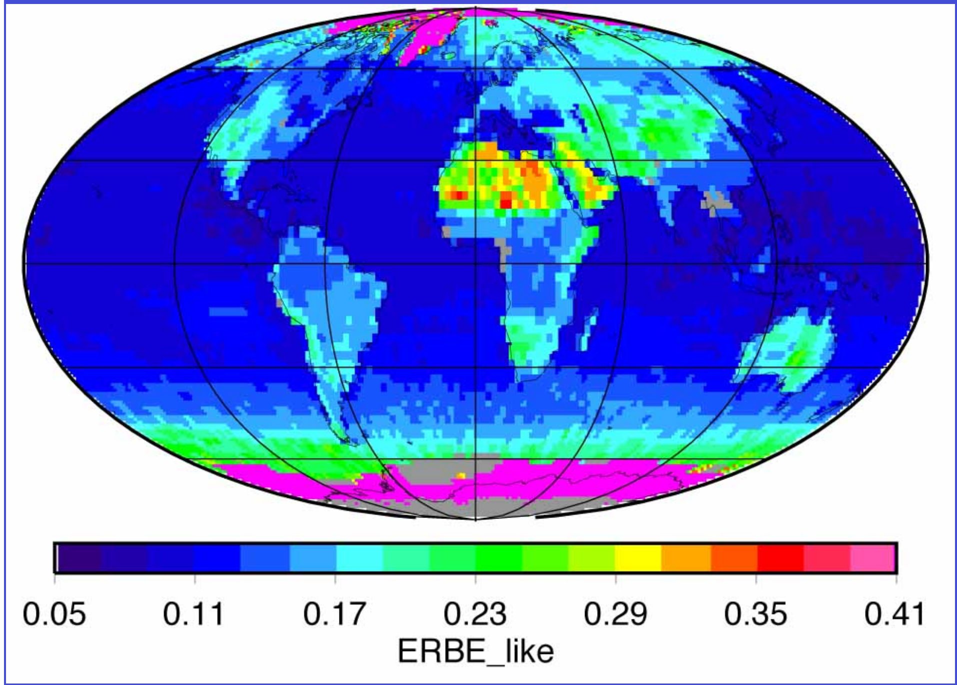
- Product Features:
  - CERES TOA fluxes and MODIS cloud properties



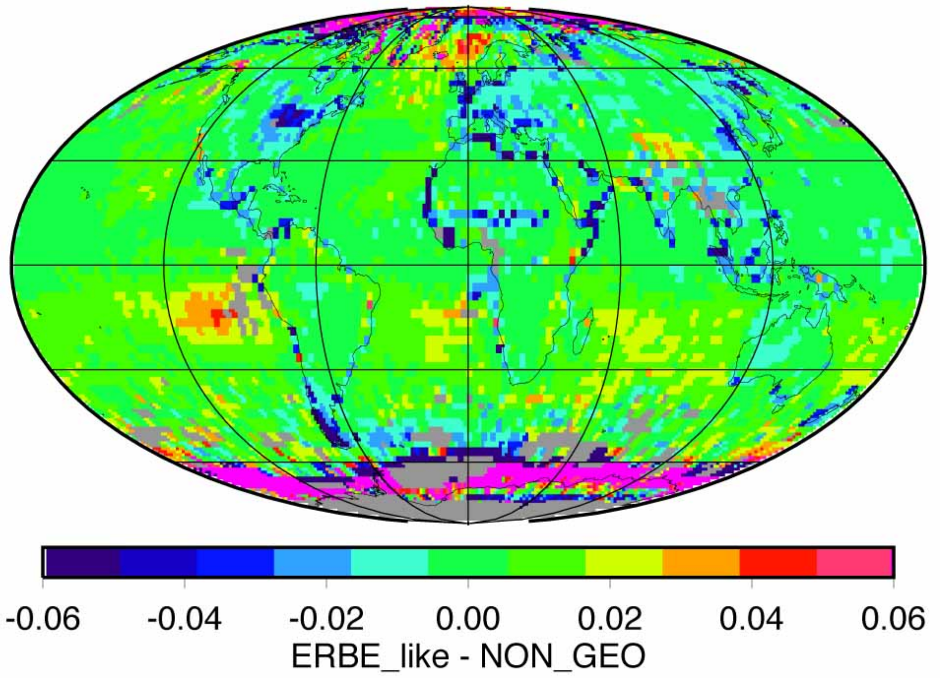
- Appropriate Usage:
  - **SSF/SFC** products provide the instantaneous fluxes
  - Fluxes and cloud properties are sampled only during Terra overpasses

Aug 2002 Clear-sky Albedo

ERBE like mean



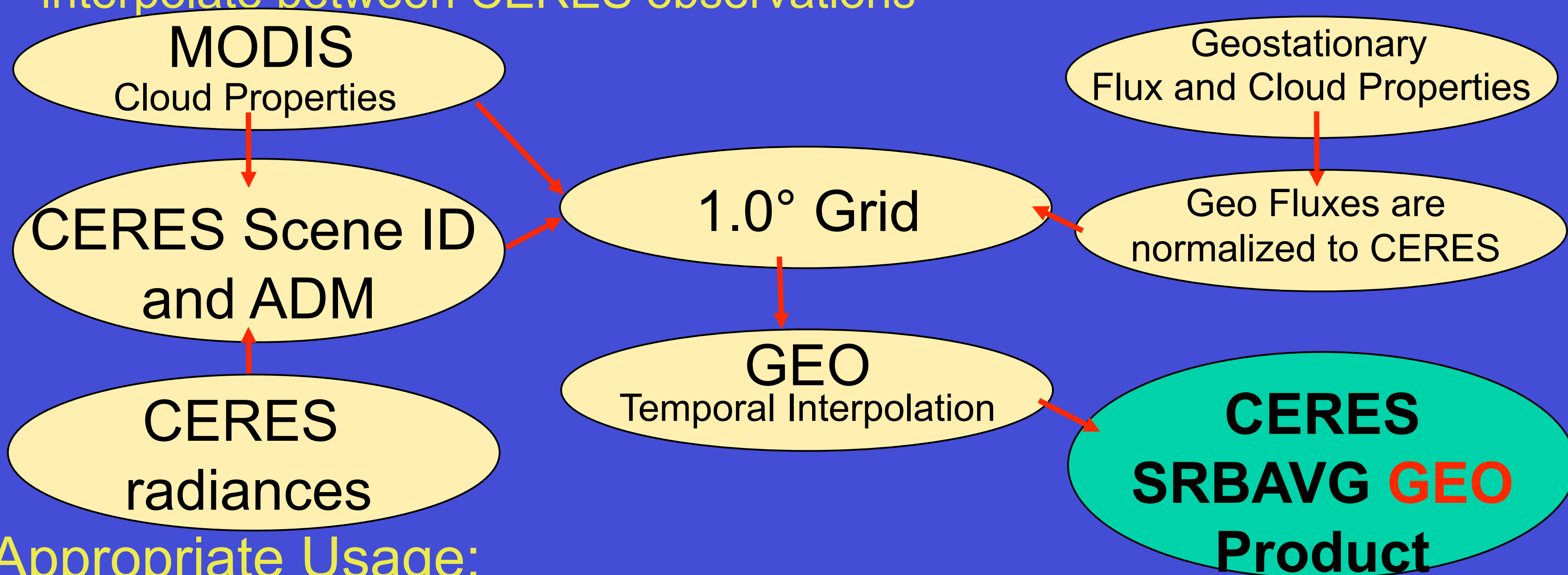
ERBE like - nonGEO



- The CERES ADMs and scene identification is an improvement over ERBE-like
  - especially clear-sky scene identification, and polar cloud retrievals
- CERES ADMs show no dependencies with cloud properties or regionally

SRBAVG GEO Product

- Product Features:
  - TOA and surface fluxes and MODIS/GEO cloud properties
  - Uses 3-hourly geostationary derived fluxes and cloud properties to interpolate between CERES observations

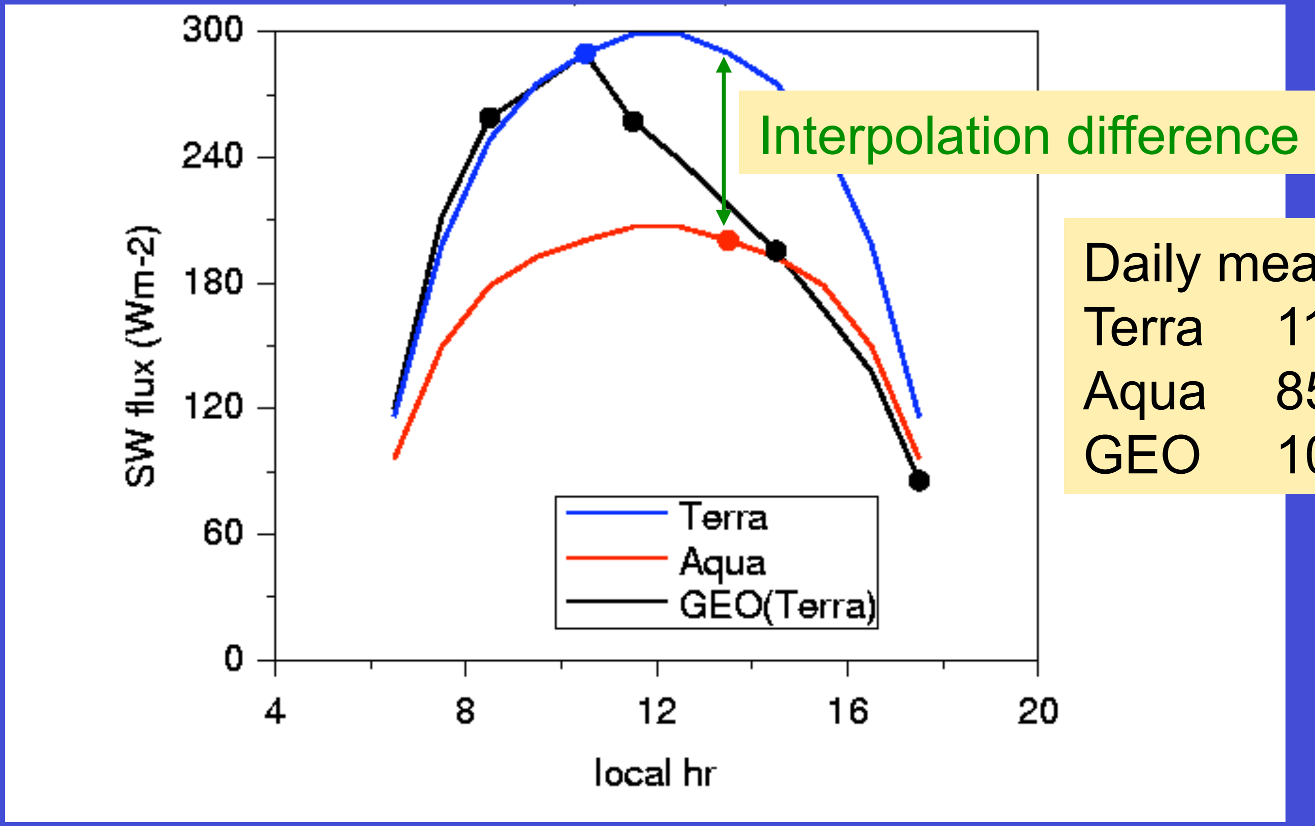


- Appropriate Usage:
  - The SRBAVG GEO product is the most robust diurnally averaged CERES TOA monthly mean flux product and of climate quality

SW Diurnal Averaging

Convert instantaneous measured flux to daily mean flux

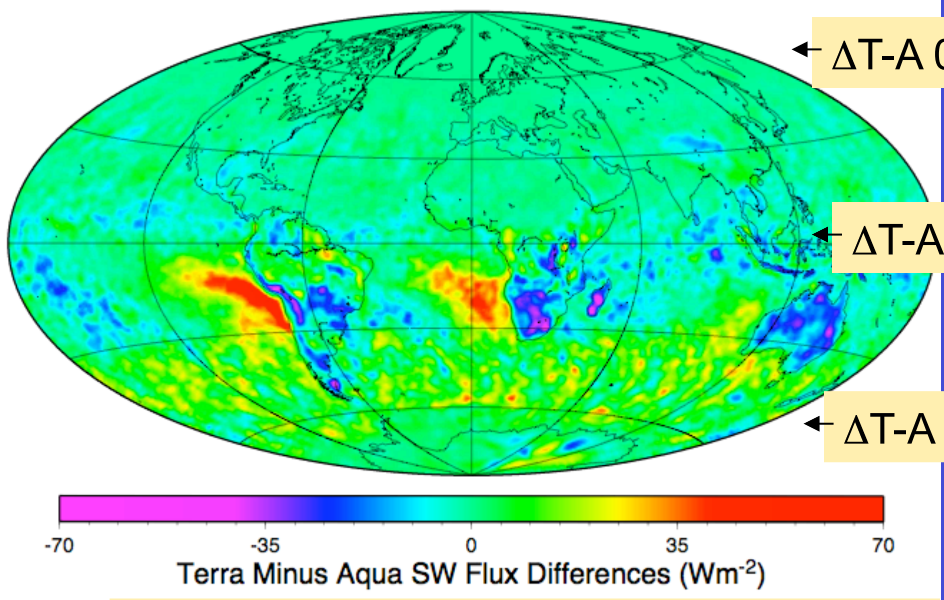
Example: Peruvian stratus region



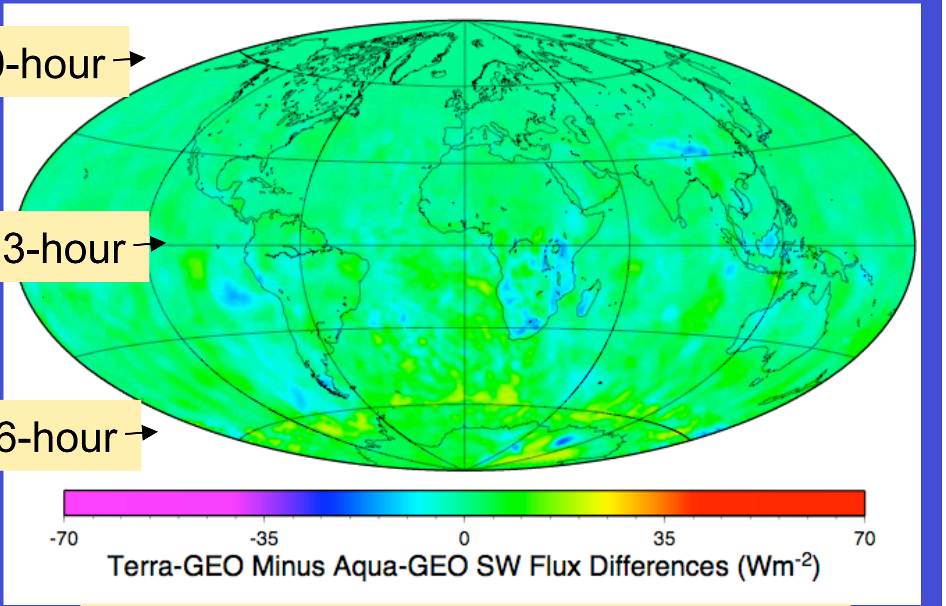
Daily mean (Wm-2)	
Terra	119.0
Aqua	85.4
GEO	102.3

Terra (10:30 LT) - Aqua (1:30 LT) monthly CERES SW flux differences Dec 2002

CERES only fluxes



CERES & GEO fluxes



ΔT-A 0-hour

ΔT-A 3-hour

ΔT-A 6-hour

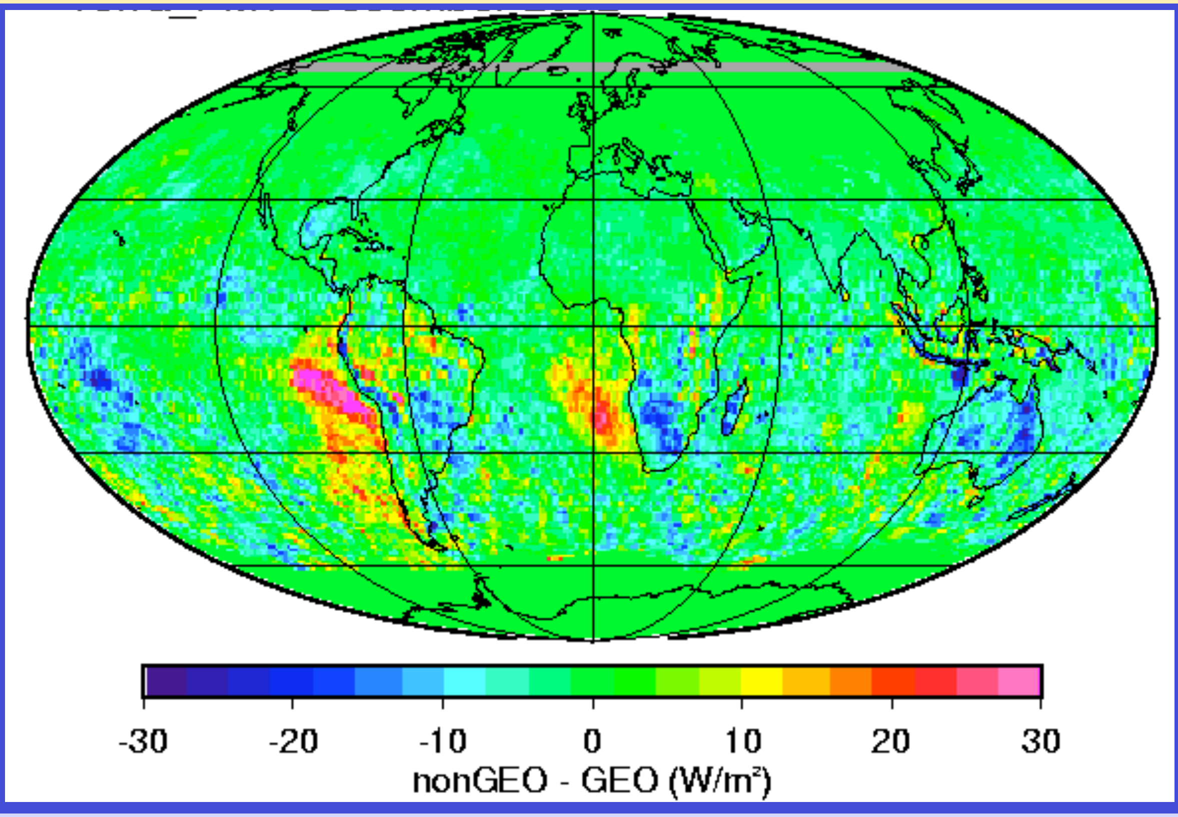
Regional rms=11.7 Wm^{-2} (11.1%)

Regional rms=4.6 Wm^{-2} (4.3%)

- Terra fluxes > Aqua fluxes over marine stratus regions (morning clouds)
- Aqua fluxes > Terra fluxes over land afternoon convection regions
- The merged GEO fluxes have removed the CERES sampling bias of the diurnal cycle

Terra nonGEO - GEO SW monthly mean
Dec 2002

- nonGEO = CERES fluxes and ERBE (constant meteorology) temporal averaging
- GEO = CERES fluxes utilizing GEO fluxes for temporal interpolation



- Regional monthly differences can be > 20 Wm^{-2}
- Global bias is - 1.0 Wm^{-2}

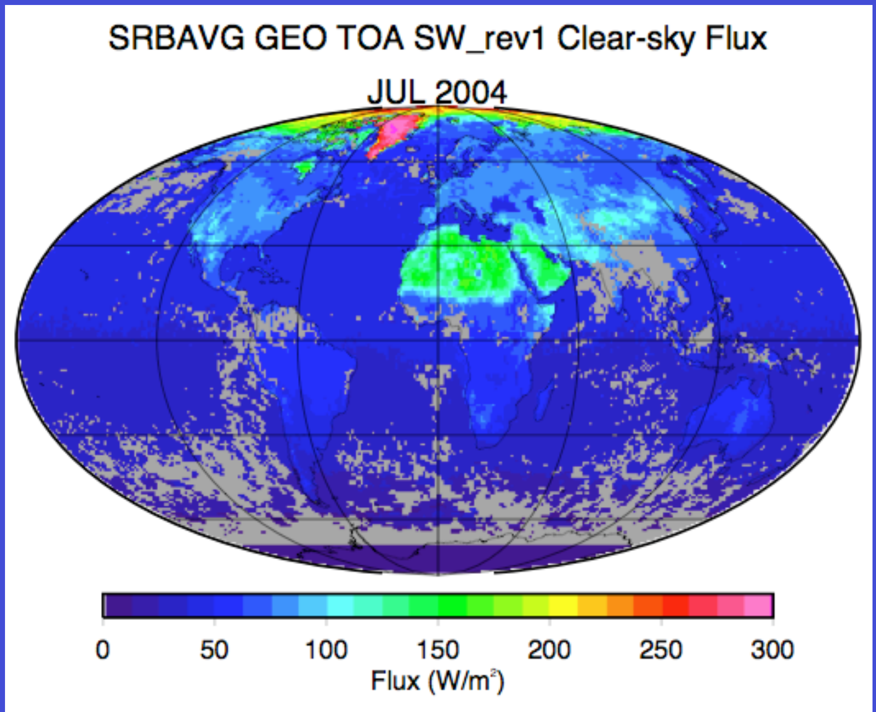
EBAF Product

- Energy Balanced and Filled (EBAF) Product Features:
  - TOA fluxes where the global net is constrained to the ocean heat storage (~0.9 Wm^{-2}) in the Earth-atmosphere system, taking into the CERES calibration and algorithm uncertainties
  - Spatially interpolates (fills) fluxes for all non observed (mainly clear-sky) regions
  - netCDF product that is Climate and Forecast (CF) compliant

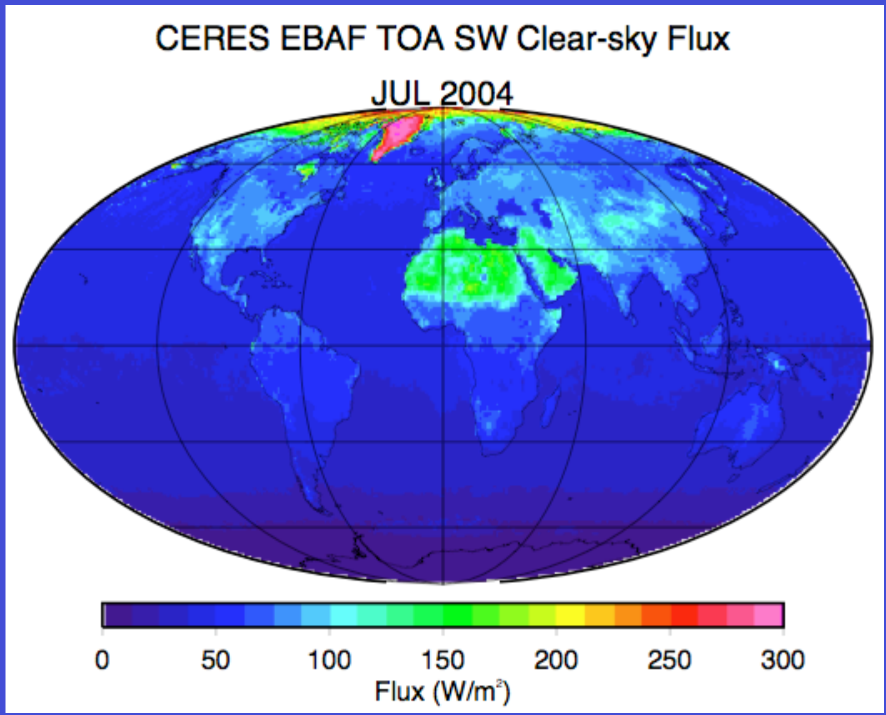
- Appropriate Usage:
  - The EBAF is for climate model evaluation
  - Estimating the Earth's annual global mean energy budget
  - Studies that infer meridianal heat transports

July 2004 Clear-sky SW

SRBAVG-GEO



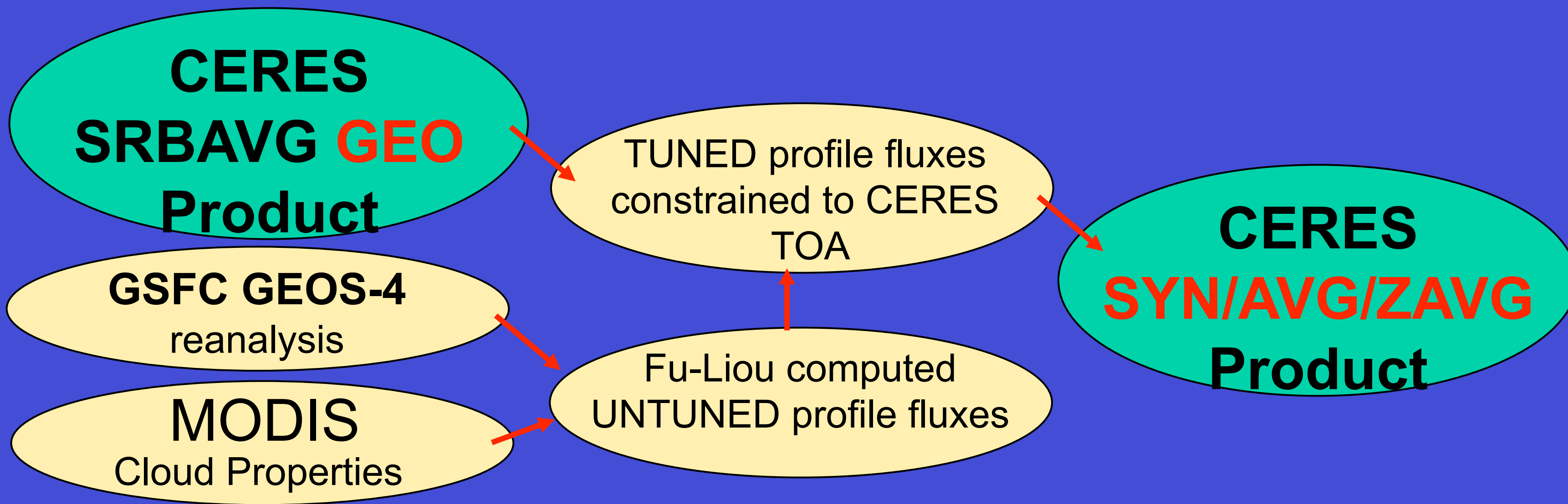
EBAF



- Note the amount of missing clear-sky SW regional fluxes
- CERES requires that 99% of the MODIS pixels within a CERES footprint are clear to be classified as clear-sky
- Missing clear-sky fluxes are based on MODIS derived broadband clear-sky pixel radiances

SYN/AVG/ZAVG Product

- Product Features:
  - –Surface and atmosphere Fu-Liou radiative transfer modeled fluxes consistent with CERES observed TOA fluxes

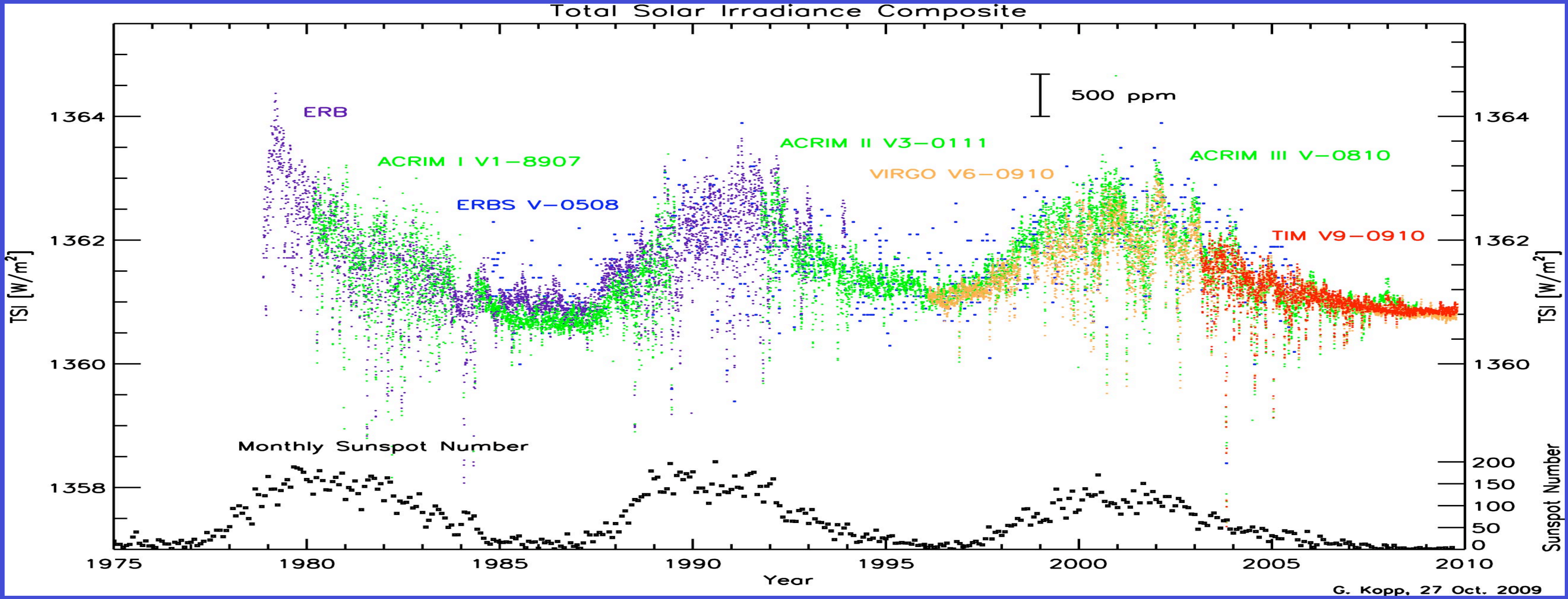


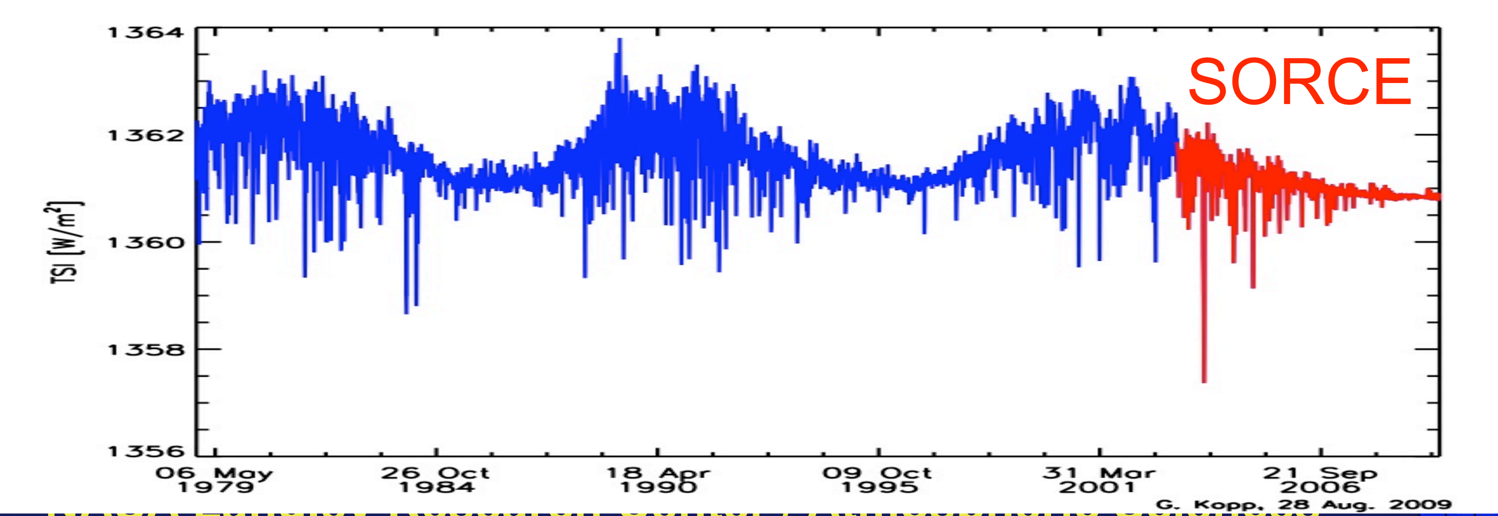
- •Appropriate Usage:
  - – SYN fluxes and cloud properties can be compared directly with climate model results at the 3-hourly or monthly level
  - – Fluxes at the surface, 500mb, 200mb, 70mb and TOA levels
  - – Fluxes under pristine, clear-sky, all-sky (no aerosol), and all-sky conditions
  - – Best surface and profile fluxes available

SSF-grid_monthly-lite_Ed2.5

- Contains the most used monthly mean parameters of the CER-SSF-grid-monthly
  - TOA fluxes (10), total cloud properties for daytime and 24-hour (9x2), MODIS aerosols (3), GEOS-4 (6), for 37 parameters
  - One file from Mar00 to Dec07 (available Dec 2009), ~0.5GB, soon to extend to Dec08
  - Compare to SSF-grid-monthly, 1.25GB/month x 94 months = ~120GB, with 225 parameters
  - **Daily_lite** also available in monthly files
- Contains the Edition3 CERES calibration
  - nonGEO flux product only, best for long term climate trend evaluation
  - Uses the Solar Radiation and Climate Experiment (SORCE) Total Solar Irradiance (TIM) Total Solar Irradiance (TSI) measurements, with a solar constant of ~1361 Wm-2

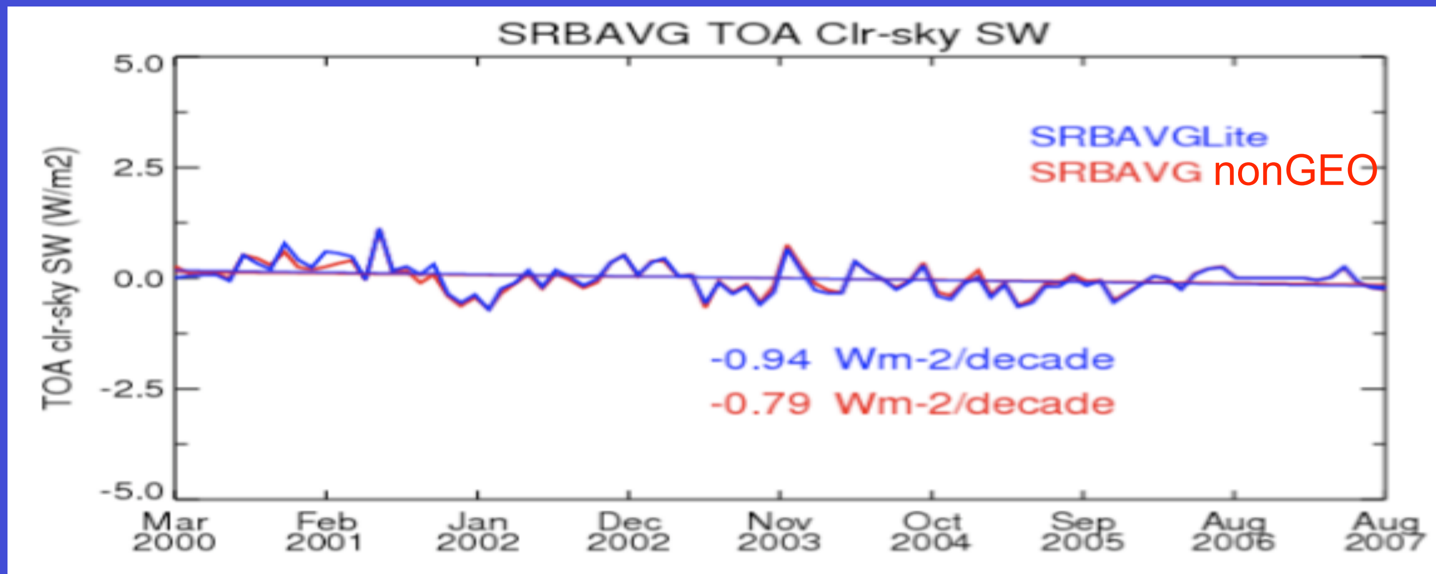
Total Solar Irradiance Composite

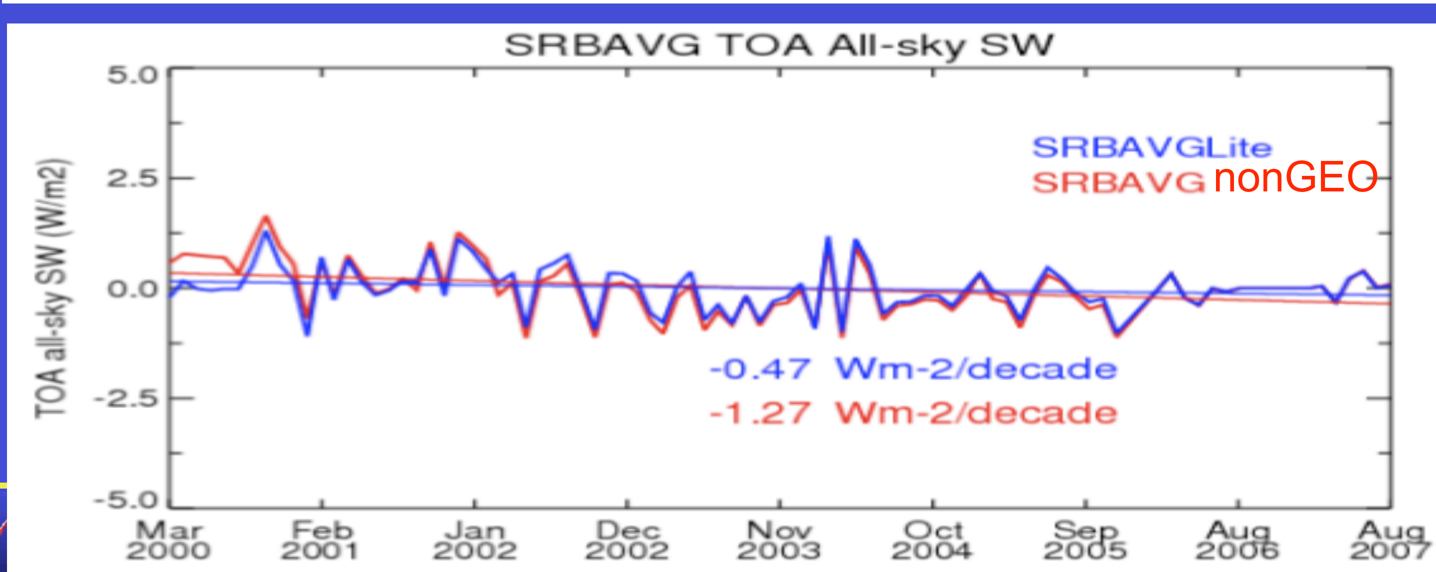




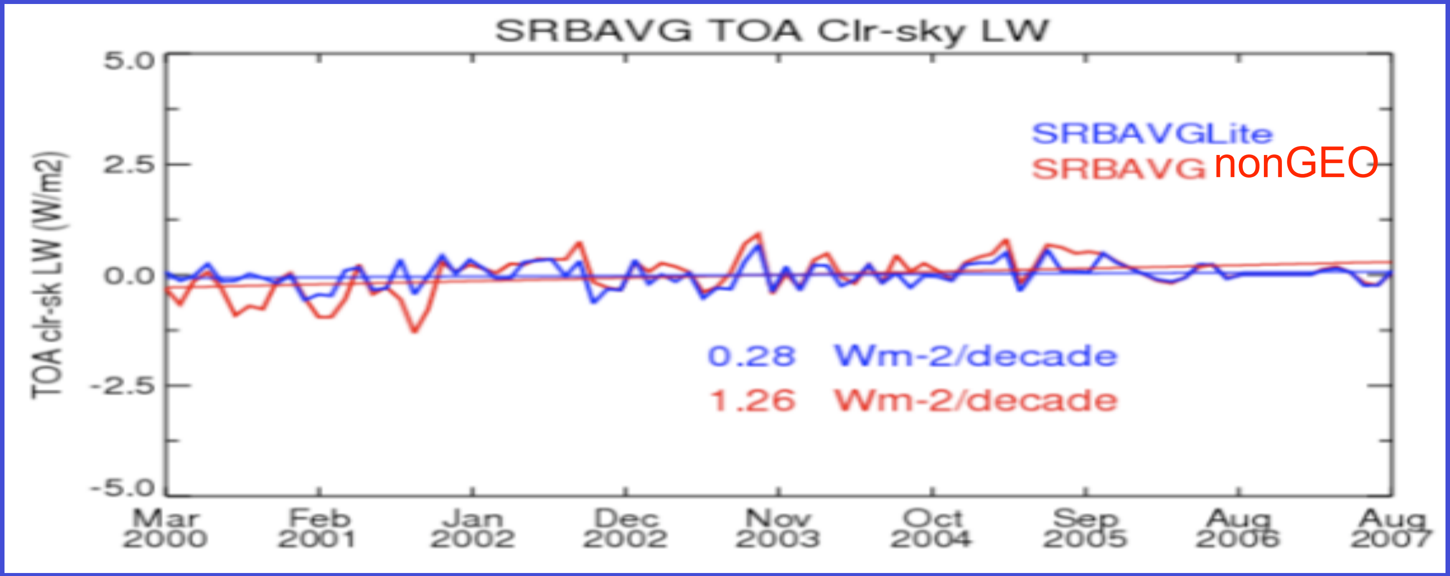
• Courtesy of Greg Kopp and SORCE

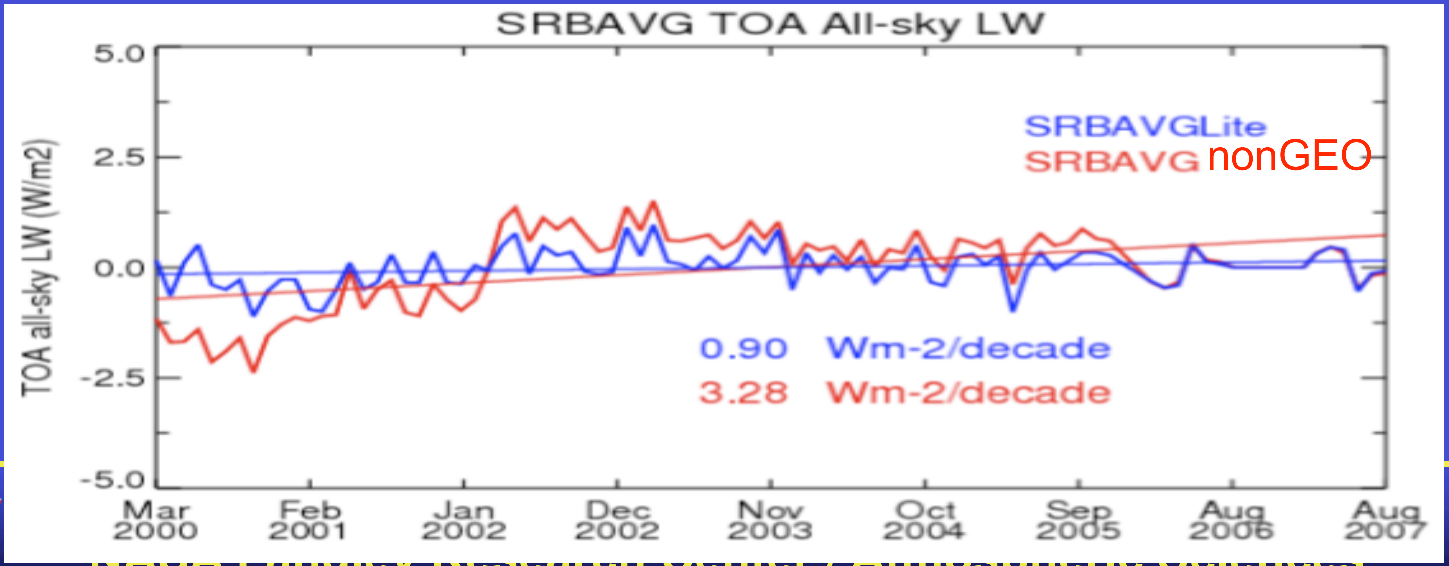
CERES SW trends, Mar00 to Aug07





CERES LW trends, Mar00 to Aug07





Global mean TOA flux comparison

Mar00-Feb04			CERES							SRB	ISCCP
TOA		ERBE-like	SRBAVG		EBAF	SYN/AVG/ZAVG			Lite Non-GEO		FD
			Non-GEO	GEO		Obs	untuned	tuned			
SWdn		341.3	341.3	341.3	340.0	341.3	341.3	341.3	340.0	341.8	341.3
All-sky	OLR	239.0	237.7	237.2	239.7	238.8	237.8	238.1	239.0	240.5	235.6
	SW	98.3	96.6	97.7	99.5	98.0	98.3	97.8	96.7	101.8	105.2
	NET	3.9	7.0	6.5	0.85	4.6	5.2	5.4	4.8	-0.4	1.0
Clear-sky	OLR	266.7	266.4	264.1	269.5	265.9	262.4	262.7	267.0	268.0	262.0
	SW	49.3	51.2	51.1	52.5	51.0	52.2	52.3	50.3	53.7	54.6
	NET	25.3	23.8	26.2	18.1	24.3	26.7	26.3	23.0	20.1	25.3
Cloud Forcing	OLR	27.6	28.6	26.9	29.8	27.3	24.6	24.6	28.0	27.4	26.4
	SW	-49.0	-45.4	-46.6	-47.1	-47.0	-46.1	-45.5	-46.4	-47.5	-50.9
	NET	-21.4	-16.8	-19.7	-17.3	-19.7	-21.5	-20.9	-23.2	-20.0	-24.5

ADM improvement

Diurnal improvement

Net balanced

LW Ed3β

Computed

Tune to CERES (Obs)

Ed3

ISCCP clouds

CERES Ed3 ordering tool

"I think it is important that NASA delivers the data to the US public, obtained with their tax dollars, in a way that are useful for greater good and do not remain confined to only a selected group. " (User comment, August 24, 2009)

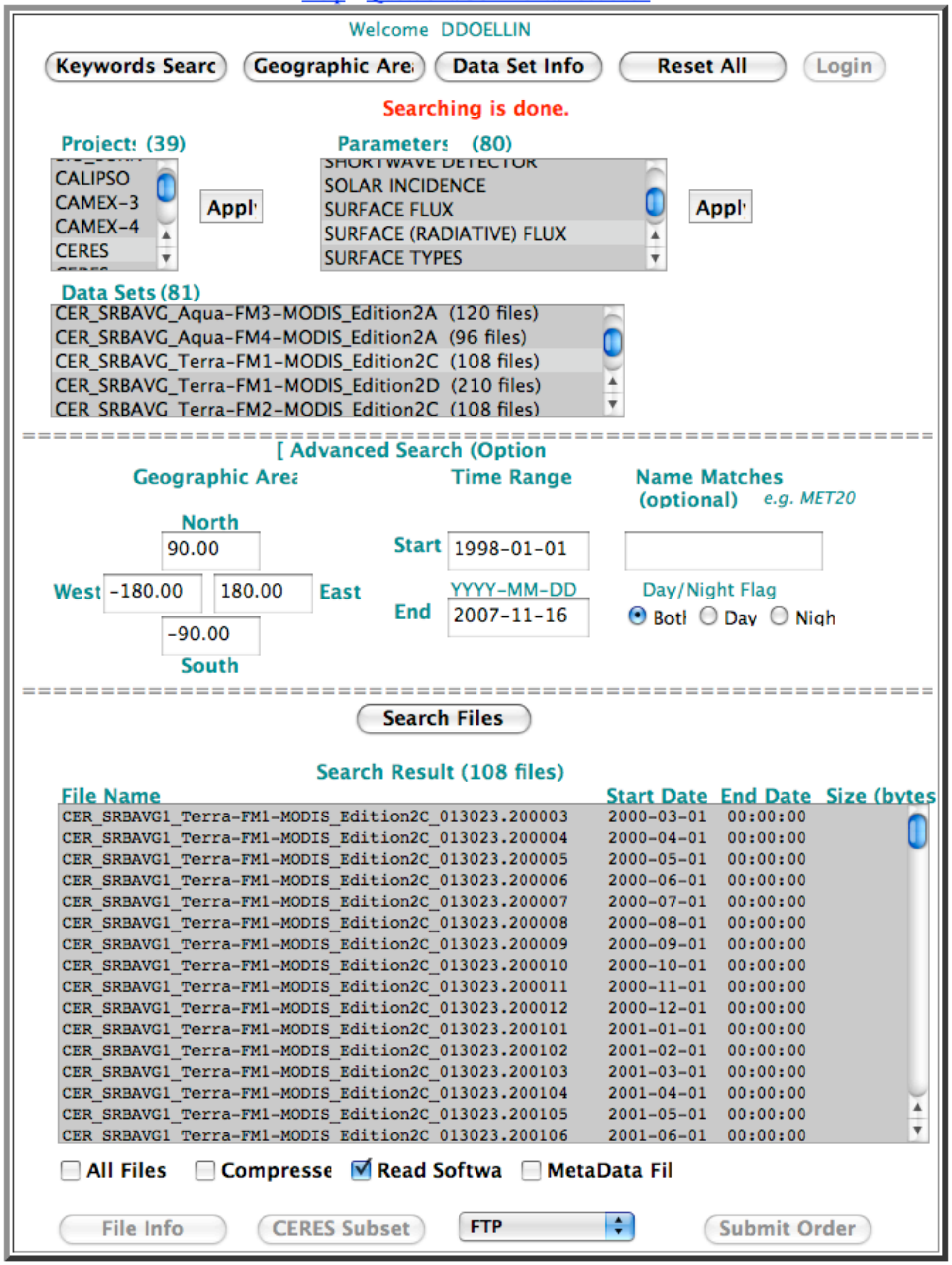
D. Doelling
NASA LaRC

C. Chu, E. Kizer, C. Mitrescu, T. Chee, E. Heckert
SSAI

ATMOSPHERIC SCIENCE DATA CENTER

ASDC Java Order Tool

Help | Questions/Comments/Feedback



CERES Ed2 Ordering Experience

- User wants to order global monthly mean surface fluxes

User needs to

- Select from SSF, SFC, SRBAVG, SYN, AVG, ZAVG, what are the time and spatial averaging scales?
- Select from Edition2A, 2B, 2C, 2D, Do I use the latest?
- Select from Aqua FM3, FM4, Terra FM1, FM2, whats in cross-track mode?
- Highlight files, there are 210 CER_SRBAVG_MODIS_Edition 2D files
- Download GB's of HDF monthly files and learn to read HDF data
- Do I use Model A,B, untuned or tuned surface fluxes
- No browser available to make sure I read data correctly

Ed3 should have user friendly products

- Edition3 is our chance to organize the CERES products into a more user friendly way
  - If we wait for Ed4 or NPP, CERES products will be set in stone
  - Ed2 was PGE driven, based on monthly processing with all temporal scales and algorithm (nonGEO, GEO) in the same file
  - Reorganize files based on stream (algorithm) and temporal averaging extent
  - Post process files to make them CF compliant and provide multi-year datasets
- There are many CERES parameters that are derived from multiple approaches and instruments
  - TOA Fluxes: ERBElike, nonGEO, GEO, computed, EBAF, which Ed, which FM1-4?
  - Surface Fluxes: Model A,B or C, computed
  - **Need a better way informing the user which approach to use based on application, what is the most robust method?**
- Need to subset the parameters from the product
  - The HDF files include every possible parameter, users only interested in a few parameters
  - Users want easily readable file formats, netCDF, ascii
  - Users are parameter driven not product driven
  - Include a product visualizer or browser

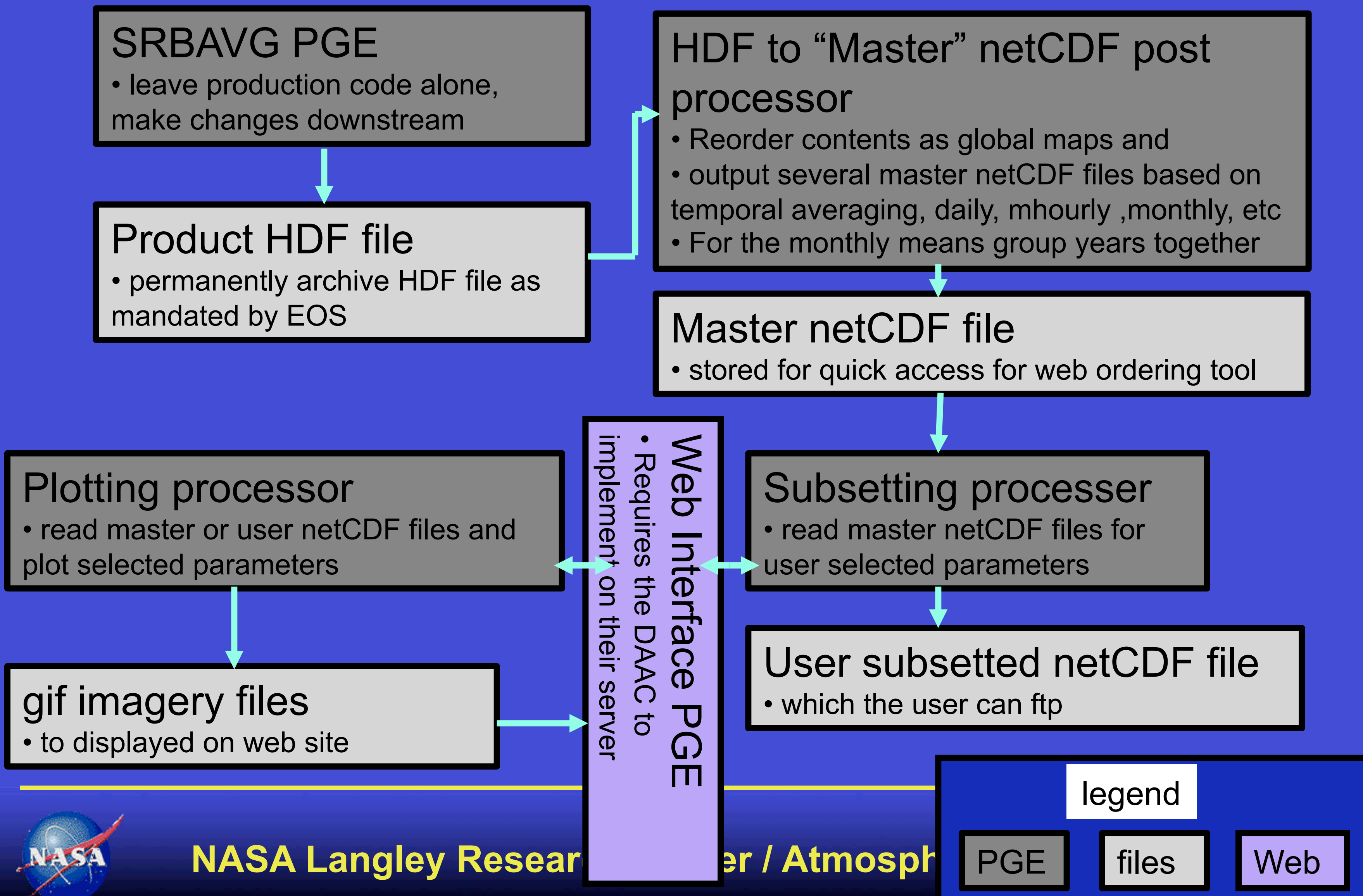
Which CERES data product do I use

CERES Stream Quick Selection Guide

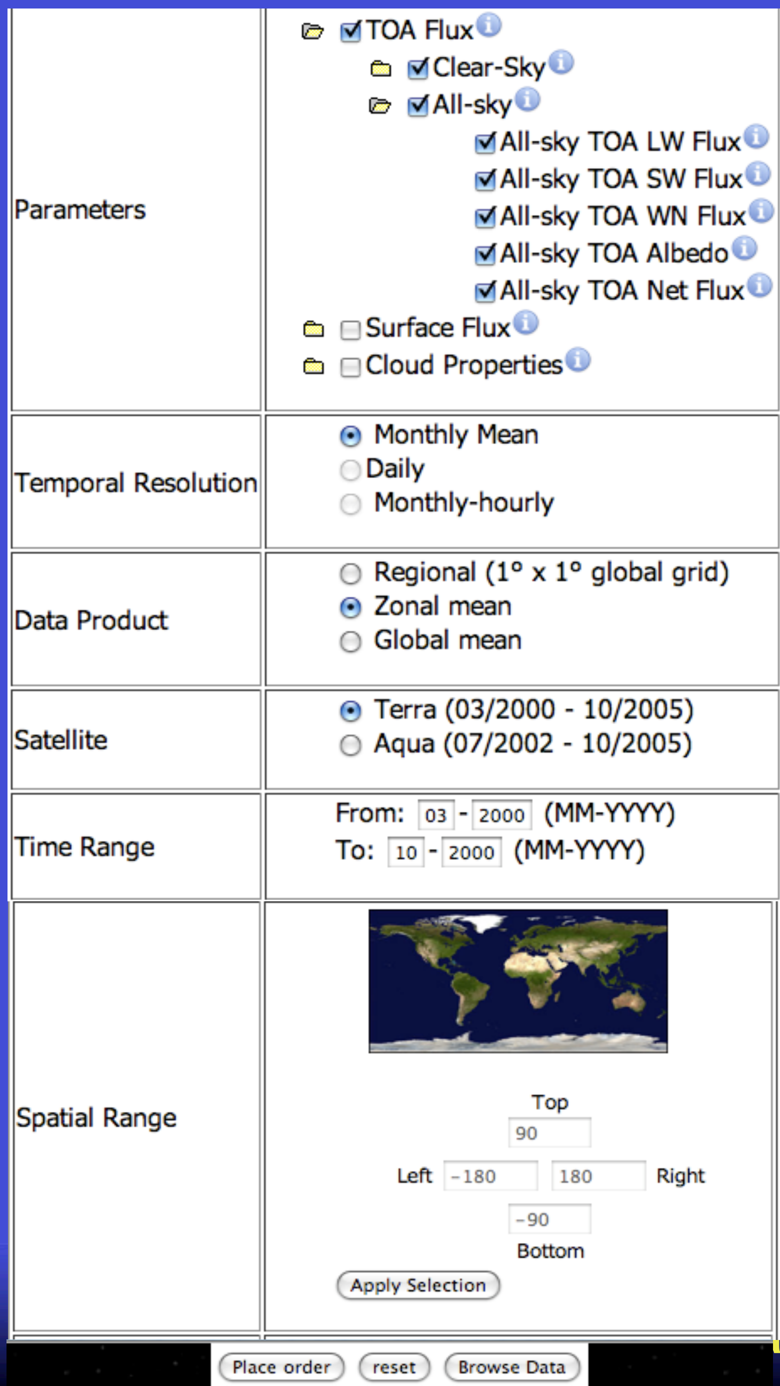
- CERES best estimate (net-balanced) TOA fluxes, use **EBAF**
  Especially for evaluation of climate model and energy budget
- CERES best estimate surface fluxes, use **SYN**
- CERES consistent flux and cloud properties, use **SYN**
  At the instantaneous footprint level, use **CRS**
- CERES TOA fluxes for long term climate trend evaluation, use **SSF**
  with associated cloud and aerosol properties
- CERES instantaneous footprint radiances, fluxes and MODIS clouds, use **SSF**
- CERES TOA fluxes and clouds to compare with A-train (Aqua) products, use **SSF**
- Compare original ERBE (1985-1989) fluxes with CERES, use **ERBElike**
  no CERES algorithm improvements
- CERES monthly cloud properties in a similar format to ISCCP, use **ISCCP-D2like**
- CERES quicklook (near realtime), use **FLASHFLUX**

- Forming a new tiger team to develop CERES landing and product selection web pages, let me know if you are interested

Subsetting flow chart for Product delivery



Subsetter Page



• User will first the pick the “stream” (SSF,EBAF) based on user application with the aid of web pages

• There are too many parameters for a pull down menu, use retractable folders to organize parameters
• Parameter information pages are provided

• Pick spatial and temporal resolution of stream

• The subsetter will pick the cross-track months

• Time range updated for either Terra or Aqua

• User can select a 1°x1° region to compare with surface data at the regional, zonal or global level

• Only the latest Edition can be ordered
• The subsetter will order all files within time range

• User can either order the data or visualize the parameters

CERES Parameter Information Web Page

CERES Parameter Information: All-sky TOA LW Flux

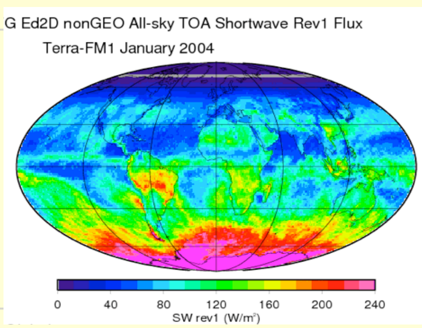
This parameter is an estimate of the instantaneous thermal flux emitted from the Earth-atmosphere at the colatitude and longitude position of the CERES footprint. (Note that colatitude and longitude are defined at the surface.)

- Attributes -

Name	Processing Stream	Temporal Resolution	Spatial Resolution	Units	Range	Data Type
LW All-Sky TOA up	SSF	Monthly	1^{o} x 1^{o}	W m^{-2}	0 .. 400	32-bit real

- Dimensions -

Name	Elements	Specification
Longitude	360	Index #0 centers at 89.5 N; proceed South at 1^{o} resolution. Index #179 centers at 89.5 S
Latitude	180	Index #0 centers at 179.5 W; proceed East at 1^{o} resolution. Index #359 centers at 179.5 E
Time	72	Expressed in days since start date. Index #0 represents first month (March 2000), Index #71 represents last month (August 2007)



- A short description of the parameters is given

- The attributes and dimensions of the selected parameter are similar to what is in the Data Products Catalogue (DPC)
- DPC are saved in a database

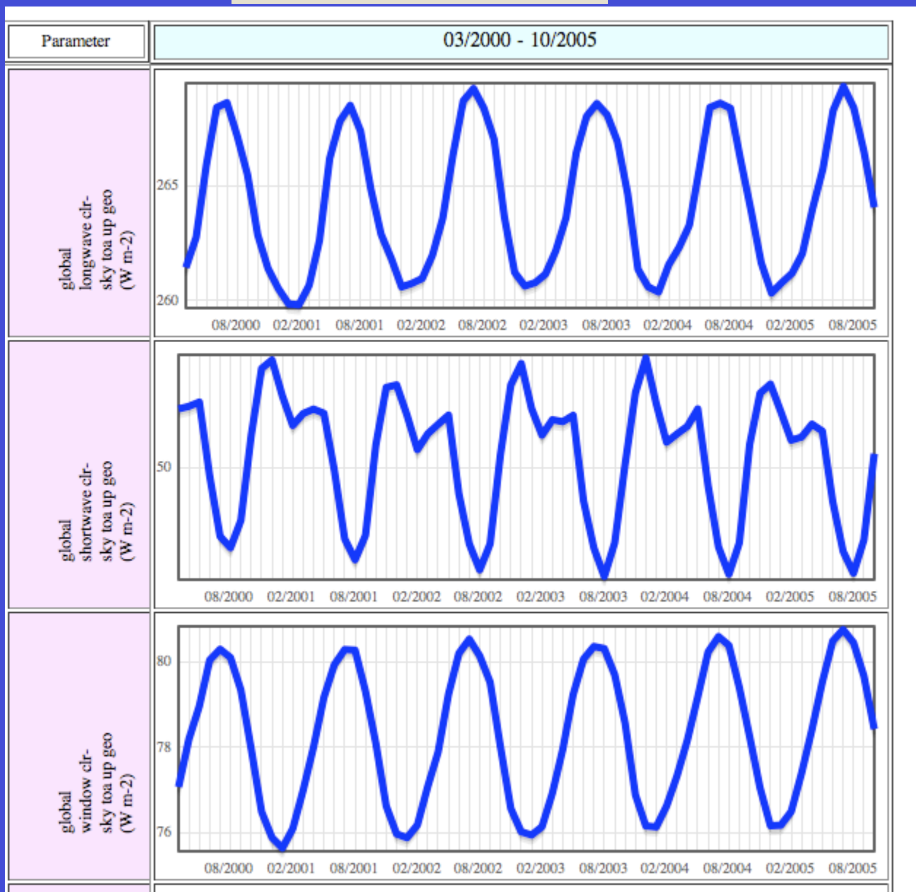
- When user has ordered the data a DPC will be generated based on the selected parameters

- Any cautions in the Data Quality Summary (DQS) will also be shown

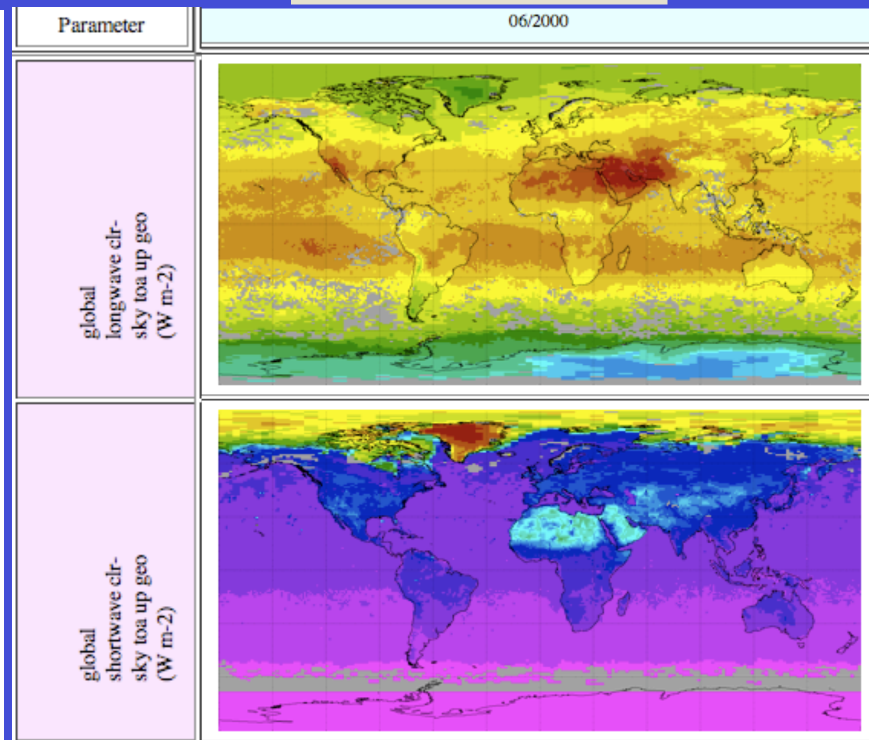
- A thumbnail example plot of the selected parameter will be shown, Is this what I want?

Examples of data visualizer

Global Means



Regional Means



- Plotting package is in Java script, works on all AMI chips, no licensing issues no IDL is used
- Parameter plots can either be animated to see many years of data or laid out in a grid
- Able to put cursor on a point on the plot and see the parameter value
- Churngwei is working on labeling and ascii ordering (single parameter) functionality

Subsetted Data Product Catalogue

Table of TOA parameters

NetCDF Name	NetCDF index	Stream	Temporal resolution	Spatial resolution	Units	Range	Data type	Dimension
All-sky TOA SW flux	1	SSF	monthly	1°x1° gridded	Wm-2	0-2000	32 bit Float	Nlon•Nlat•N months
All-sky TOA LW flux	2	SSF	monthly	1°x1° gridded	Wm-2	0-2000	32 bit Float	Nlon•Nlat•N months
Clear-sky TOA SW flux	3	SSF	monthly	1°x1° gridded	Wm-2	0-2000	32 bit Float	Nlon•Nlat•N months
Clear-sky TOA LW flux	4	SSF	monthly	1°x1° gridded	Wm-2	0-2000	32 bit Float	Nlon•Nlat•N months

Table of Dimension Definitions

Dimension	No of Indices	Name	Definition
Nlat	180	Latitude	Index #1 is at 89.5° N, proceed south, Index #180 is at 89.5° S
Nlon	360	Longitude	Index#1 is at 0.5°E, proceed east, Index #360 is at 0.5°W
Nmonth	72	Month	Index #1 is March 2000, chronological order, Index #72 August 2007

Product Size

# of parameters	4
Total File size	134 MB

Product Data Quality Summary

http://eosweb.larc.nasa.gov/PRODOCS/ceres/SRBAVG/Quality_Summaries/CER_SRBAVG_Edition2D_Terra_Aqua.

Product Attribution

The CERES Team has gone to considerable trouble to remove major errors and to verify the quality and accuracy of this data. **Please provide a reference to the following paper when you publish scientific results with the CERES SRBAVG Edition2 data:**

Wielicki, B. A., B. R. Barkstrom, E. F. Harrison, R. B. Lee III, G. L. Smith, and J. E. Cooper, 1996: Clouds and the Earth's Radiant Energy System (CERES): An Earth Observing System Experiment, *Bull. Amer. Meteor. Soc.*, 77, 853-868.

When Langley ASDC data are used in a publication, **we request the following acknowledgment be included**: "These data were obtained from the NASA Langley Research Center EOSDIS Distributed Active Archive Center."

The Langley ASDC requests two reprints of any published papers or reports which cite the use of data that we have distributed. This will help us determine the use of data that we distribute, which is helpful in optimizing product development. It also helps us to keep our product related references current.

List of HDF files used

```
CER_SRBAVG1_Terra-FM1-MODIS_Edition2C_013023.200003
CER_SRBAVG1_Terra-FM1-MODIS_Edition2C_013023.200004
CER_SRBAVG1_Terra-FM1-MODIS_Edition2C_013023.200005
CER_SRBAVG1_Terra-FM1-MODIS_Edition2C_013023.200006
CER_SRBAVG1_Terra-FM1-MODIS_Edition2C_013023.200007
CER_SRBAVG1_Terra-FM1-MODIS_Edition2C_013023.200008
CER_SRBAVG1_Terra-FM1-MODIS_Edition2C_013023.200009
CER_SRBAVG1_Terra-FM1-MODIS_Edition2C_013023.200010
CER_SRBAVG1_Terra-FM1-MODIS_Edition2C_013023.200011
CER_SRBAVG1_Terra-FM1-MODIS_Edition2C_013023.200012
CER_SRBAVG1_Terra-FM1-MODIS_Edition2C_013023.200101
CER_SRBAVG1_Terra-FM1-MODIS_Edition2C_013023.200102
CER_SRBAVG1_Terra-FM1-MODIS_Edition2C_013023.200103
CER_SRBAVG1_Terra-FM1-MODIS_Edition2C_013023.200104
CER_SRBAVG1_Terra-FM1-MODIS_Edition2C_013023.200105
CER_SRBAVG1_Terra-FM1-MODIS_Edition2C_013023.200106
```

- Links to the DQS, read software (customized), Parameter Definitions Document (PDD) and other helpful CERES web pages and CERES attribution for publication
- Keep track of parameters (stream, spatial, temporal scales) users order
- Will contain list of HDF files used to provide product name, satellite info, strategy, Ed, months, to answer user questions and traceability

Ordering Tool Timeline

- Deliver "Ed3 Alpha-2" ordering tool in November 2009
  - Demonstrate prototype at the DAAC and integrate into their system
- Deliver "Ed3 Beta" ordering tool in Feb 2010
  - Include the SSF-monthly, SSF-daily, SSF-lite, EBAF, ERBElike-ES4,
  - Add the near time products of FLASHFLUX-monthly/daily and ERBE CV
  - Tiger team to develop CERES landing web pages for the novice user
  - Let CERES users kick the tires of the subsetter, March-April 2010
  - Implement user feedback after the CERES Spring science team meeting
- Deliver "Ed3" ordering tool in May 2010
- Develop ordering tool to include footprint (SSF) and SSF-hourly (SFC) CERES products – Summer 2010
  - Work with CALIPSO project to include their features
  - Will locate files over region of interest (ground site) and then subset parameters and footprints
- Update data visualizer to include parameter difference plots and increase functionality, Fall 2010
- Incorporate SYN and CRS products into the ordering tool Spring 2011

MTSAT calibration update

"This is the worst satellite I have ever worked with in 25 years", Bill Rossow

D. Doelling

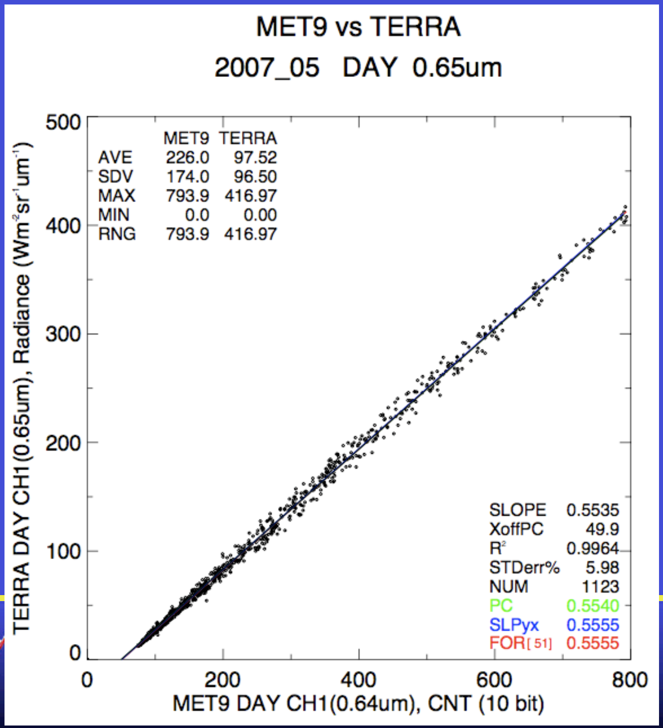
NASA LaRC

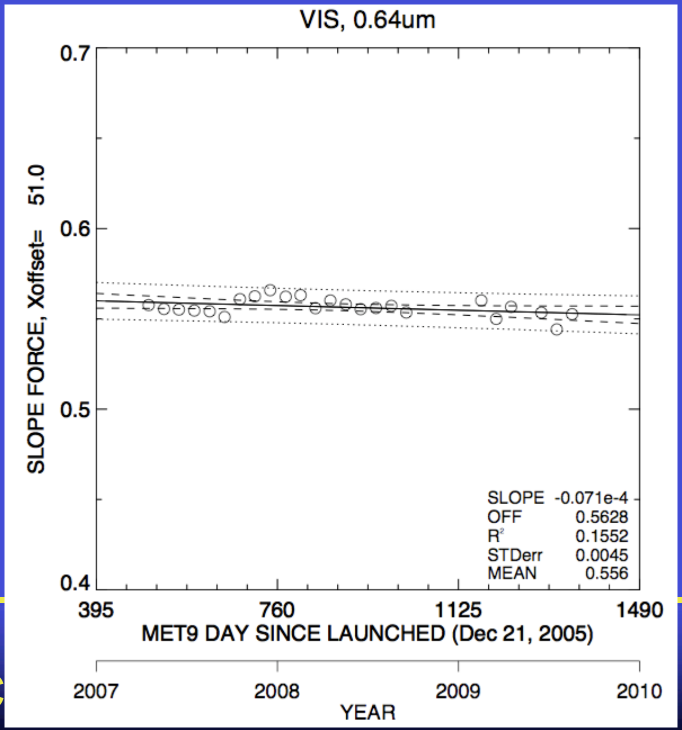
L. Avey, R. Bhatt, D. Morstad, C. Nguyen, M. Nordeen, R. Raju

SSAI

GEO to MODIS Cross-Calibration Method

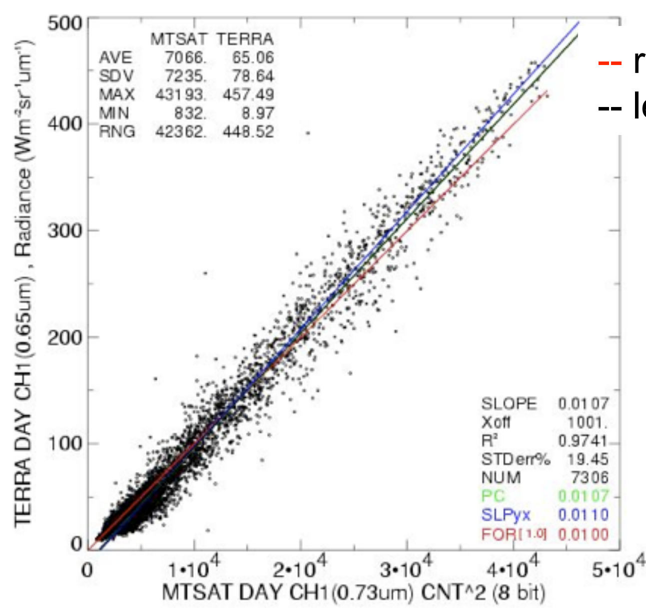
- None of the GEO visible sensors have onboard calibration
- Ray-match coincident GEO counts (proportional to radiance) and MODIS radiances averaged over a 50^2 km ocean grid near the sub-satellite point (±15° lat by ±20° lon area)
- Perform monthly regressions to derive monthly gains
- Compute timeline trends from monthly gains



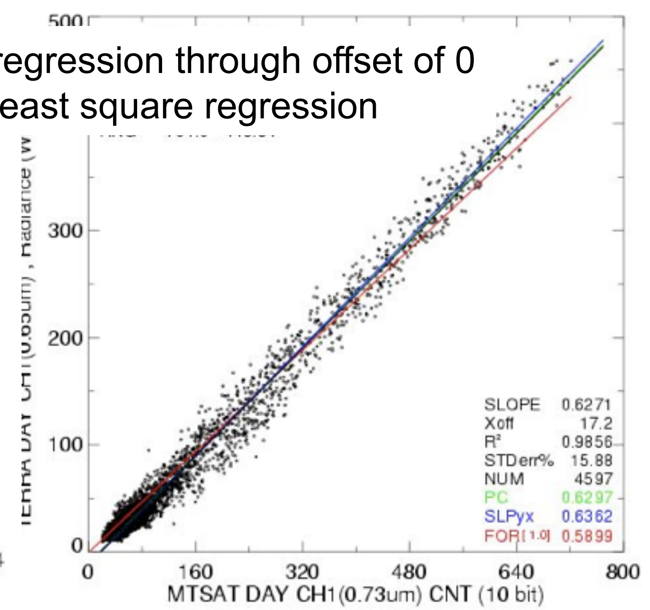


MTSAT-1R/MODIS VIS cross-calibration

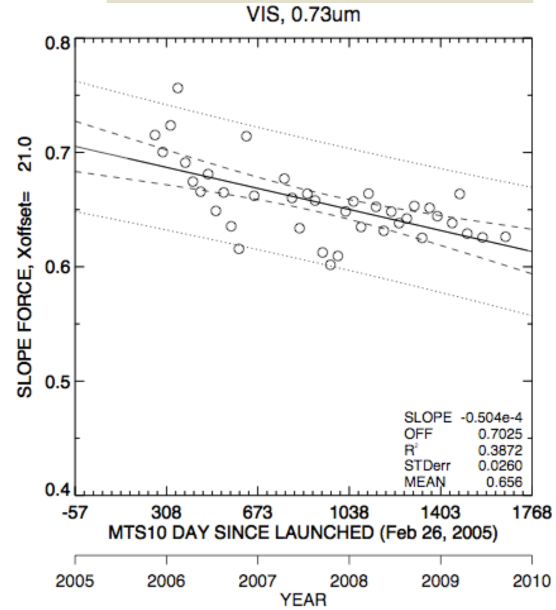
MTSAT/Terra
April 2006, 8-bit



MTSAT/Terra
April 2008, 10-bit



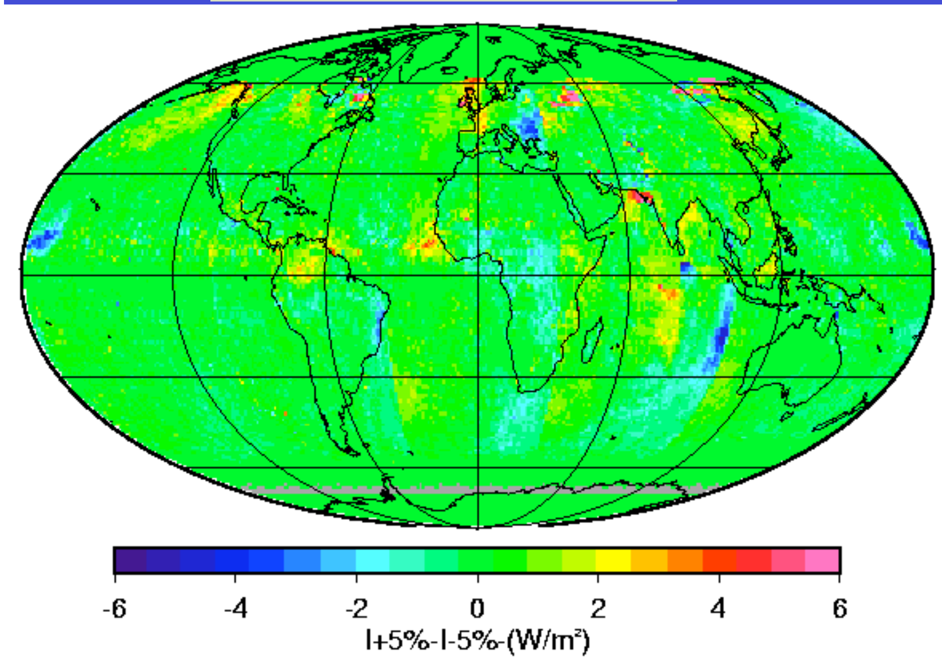
MTSAT/Terra
2007-2009



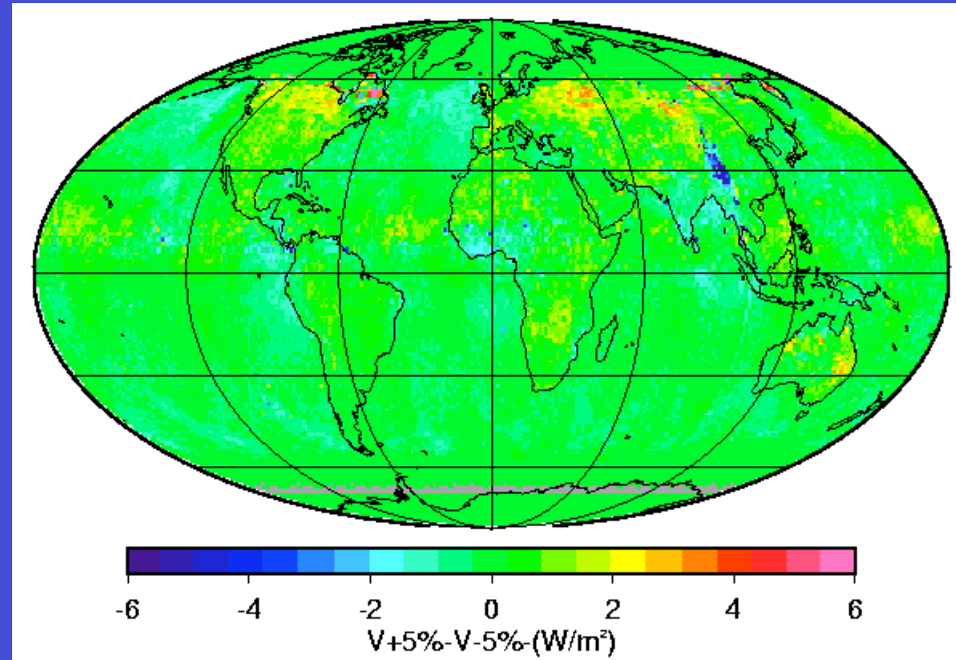
- Same ray-matching technique as the other satellites
- Note the departure from linearity in the low part of the dynamic range
- Whether 8bit count² HiRAD or 10bit linear HRIT images show nonlinear behavior
- Similar behavior for Aqua-MODIS, GOES-11 and VIRS
- MTSAT IR cross-calibration is typical of other GEOs, implying good navigation

Change in Total-Sky TOA SW Flux due to artificial GEO calibration adjustments, July 2002

(IR+5%) - (IR-5%)



(VIS+5%) - (VIS-5%)



Bias=0.10%,rms=0.9%

Bias=0.01%,rms=0.8%

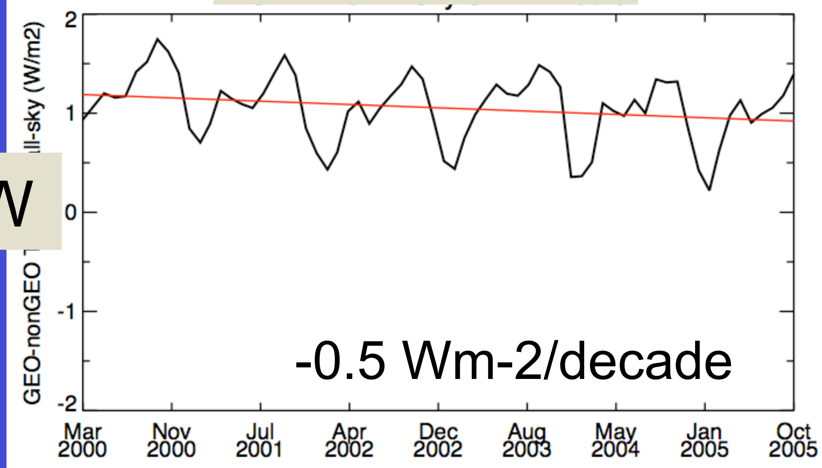
- Plotted differences are for 10% calibration change
- Actual GEO SW calibration uncertainty is 3-5% and LW is 1-2%
- GEO flux constrainment to CERES removes sensitivity to GEO calibration
- Even though MTSAT VIS is not well calibrated, it will not alter CERES calibration

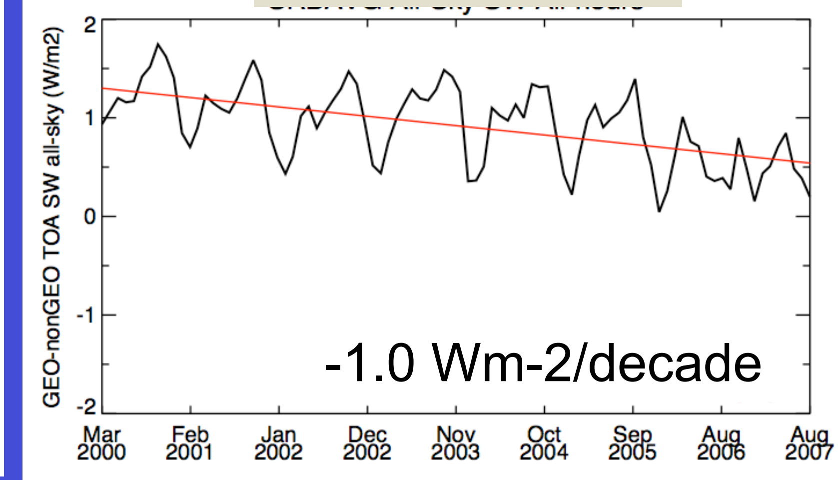
GEO-nonGEO SW, LW trends

Mar00-Oct05

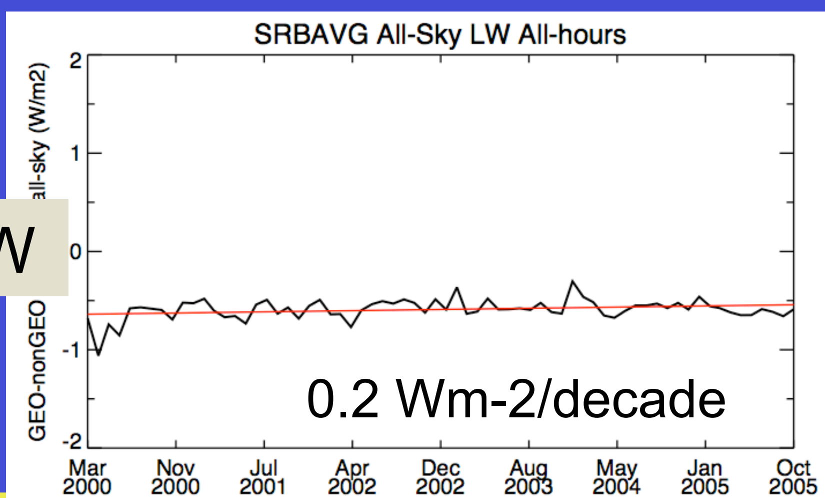
Mar00-Aug07

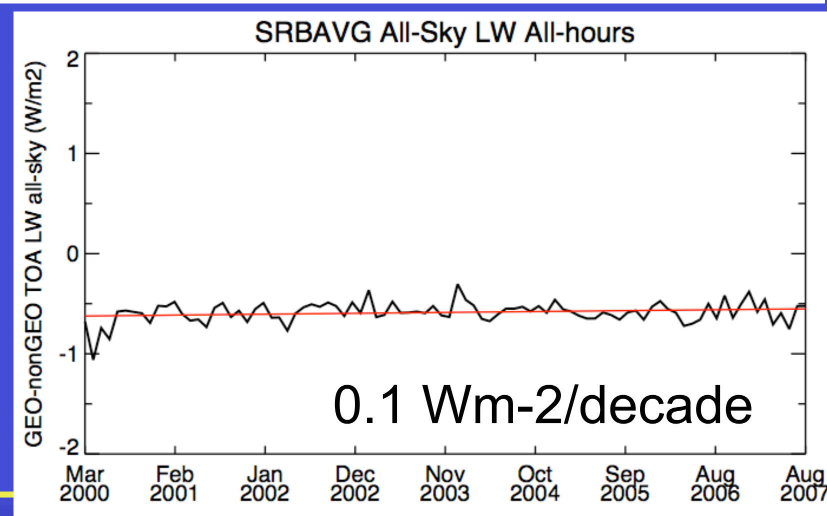
SW



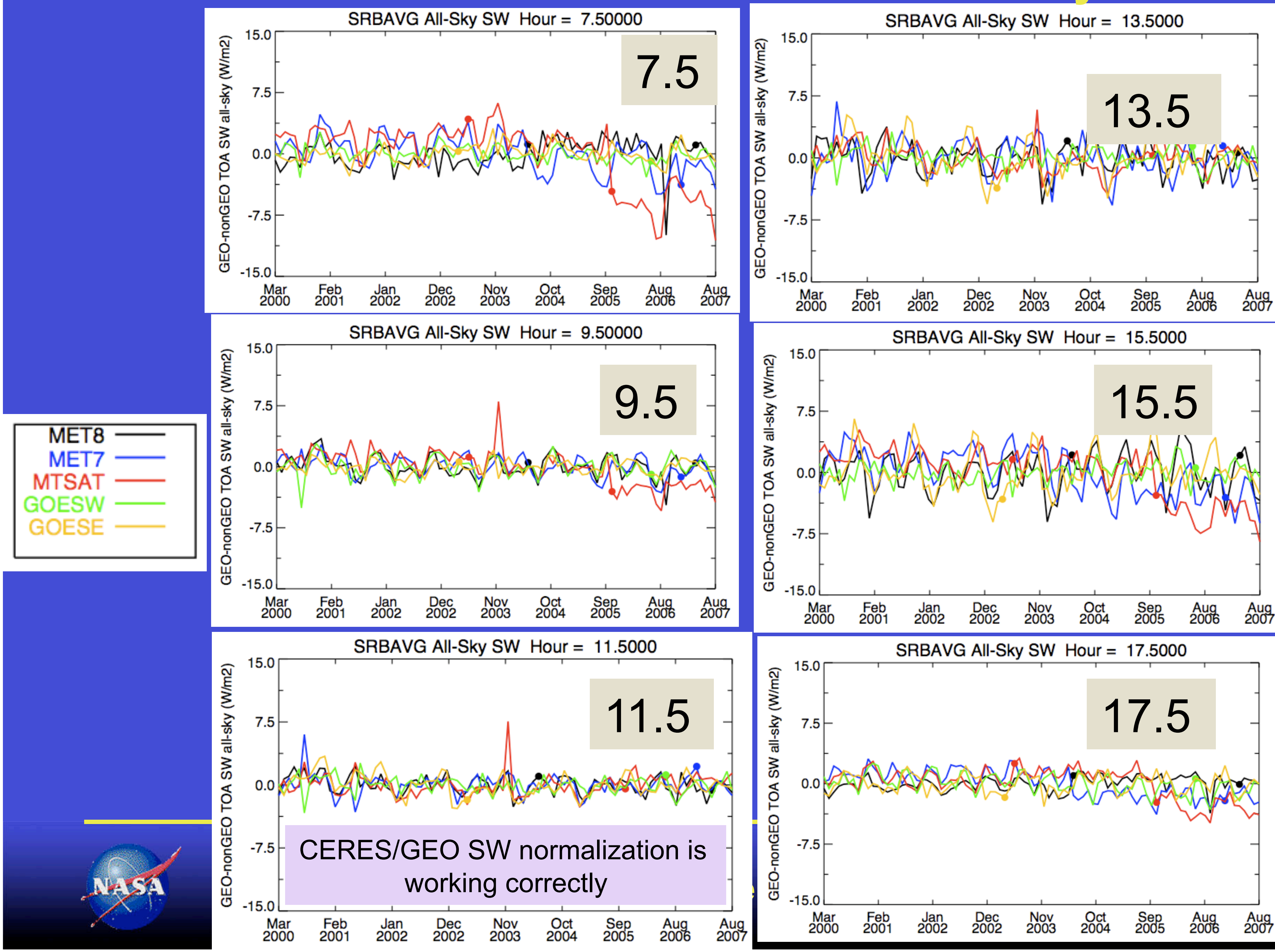


LW

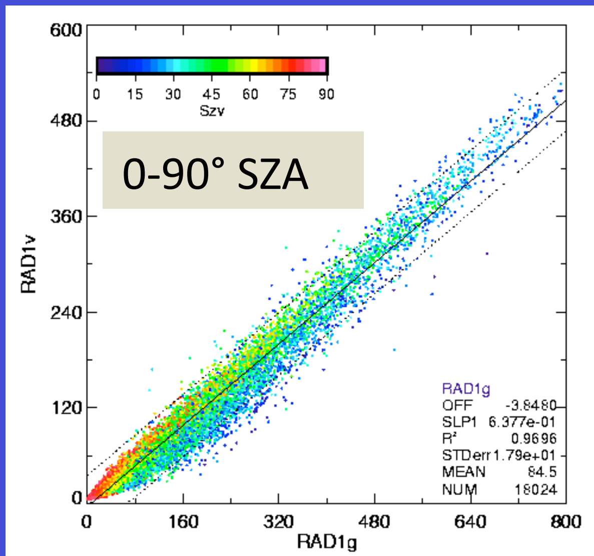




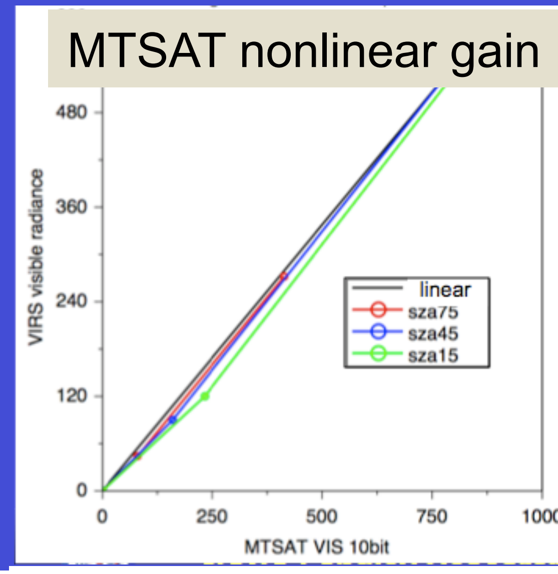
GEO-nonGEO SW deseasonalized trends by local hour

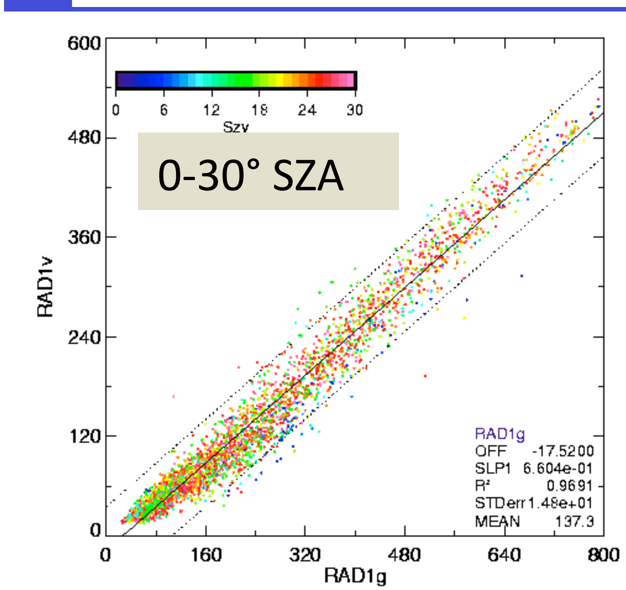


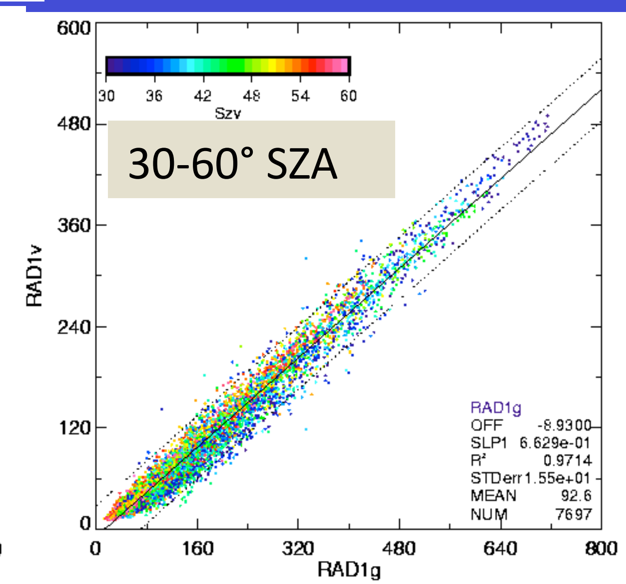
MTSAT/VIRS SEP07-MAR08

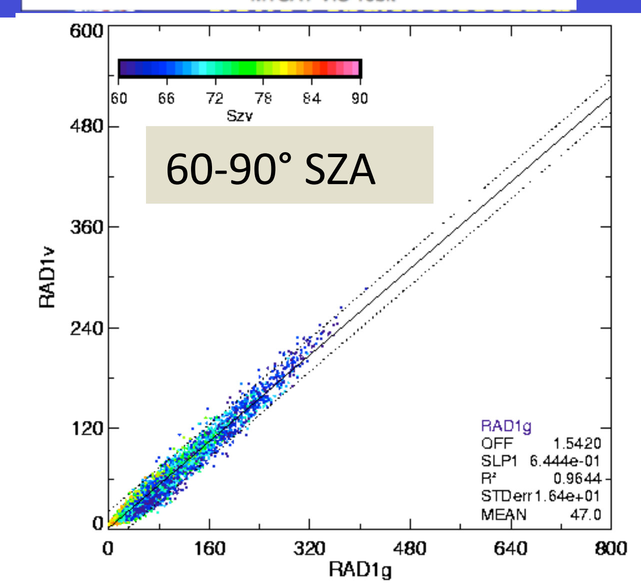


- VIRS is in a 47 day precessionary cycle observing all SZAs every 23 days
- Derive a nonlinear MTSAT gain as a function of SZA









GEO-nonGEO SW flux comparison

MTSAT nonlinear gain

Local hr	linear	0.5x VIRS	1.0x VIRS	1.5x VIRS	2x VIRS	GMS-5
7.5	-7.4	-4.0	-1.0	3.0	5.5	7
9.5	-1.1	-0.1	0.7	3.3	2.6	3
11.5	1.8	0.9	0.8	-0.8	-1.0	0
13.5	2.6	2.4	3.1	3.2	2.2	3
15.5	-3.1	0.2	3.2	7.7	9.9	7
17.5	-6.4	-3.4	-0.3	2.7	5.9	2

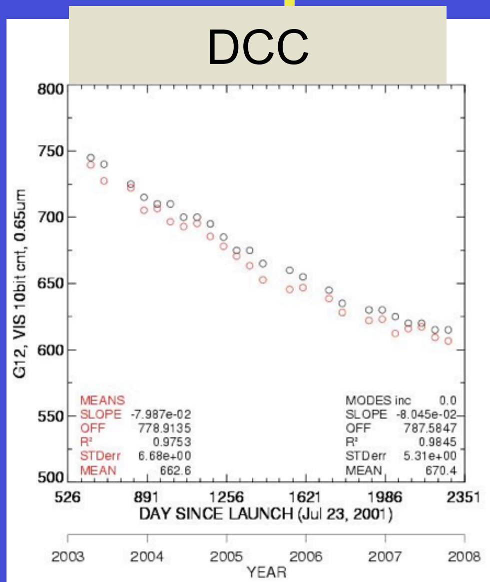
The GEO derived diurnal SW flux is much more sensitive to nonlinearity than to linear gain changes

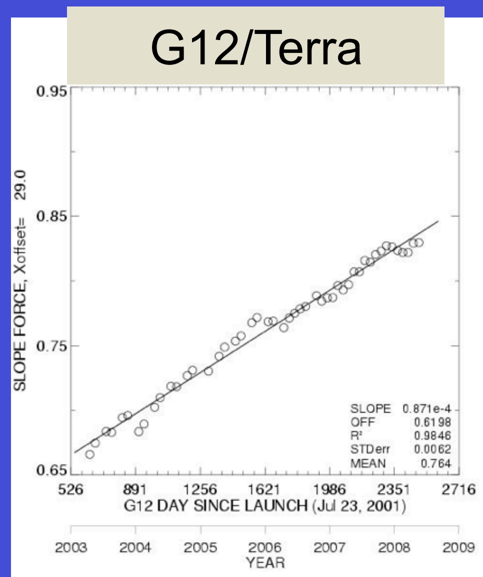
MTSAT linear gains

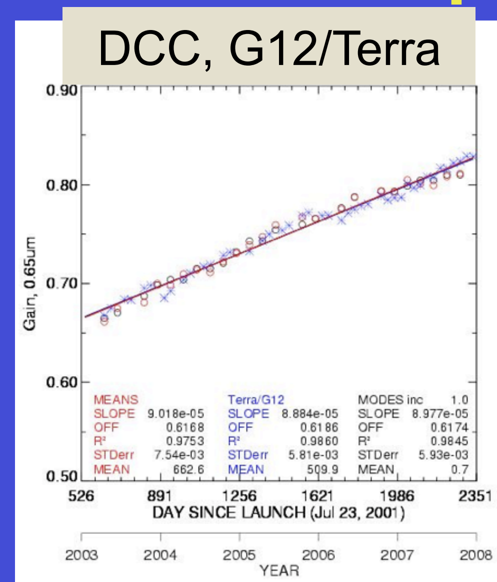
Local hr	0.59	0.62	0.65	0.68	0.71	GMS-5
7.5	-7.3	-7.4	-7.6	-7.7	-8.0	7
9.5	-1.5	-1.1	-0.8	-0.6	-0.4	3
11.5	1.7	1.8	1.9	1.9	1.9	0
13.5	2.4	2.6	2.9	3.0	2.9	3
15.5	-2.8	-3.1	-3.4	-3.7	-4.1	7
17.5	-5.7	-6.4	-7.1	-7.7	-8.4	2

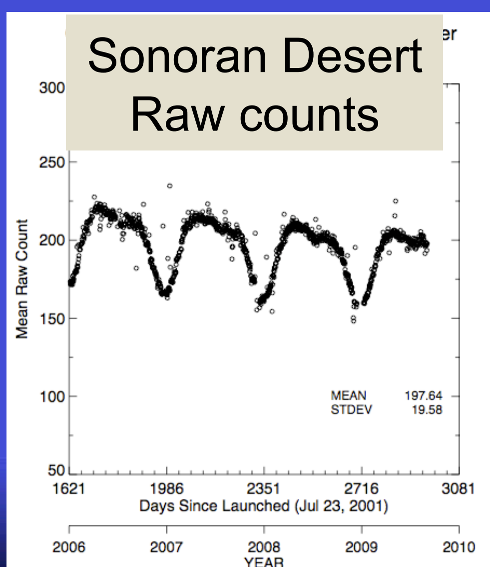
Only a drastic change in gain will result in similar GEO-nonGEO flux differnces

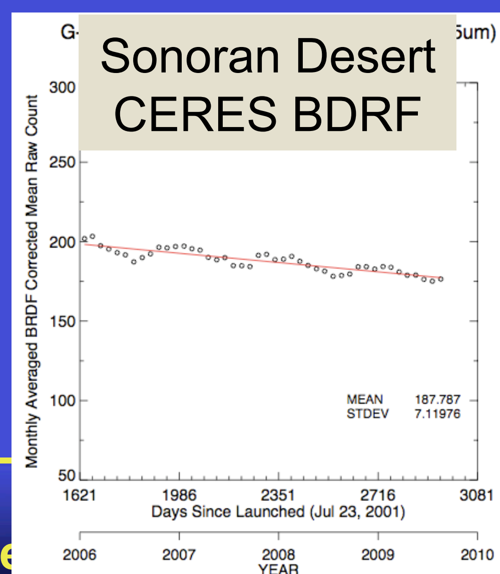
Comparison of G12 calibration Techniques

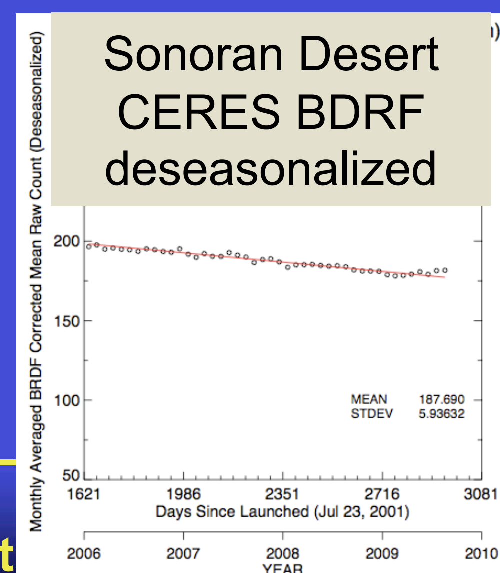




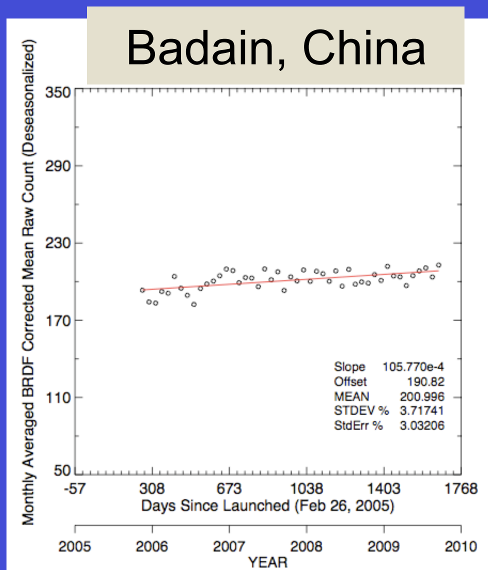


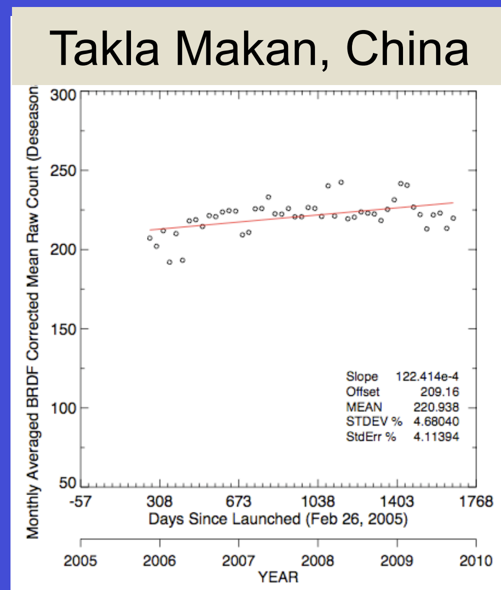


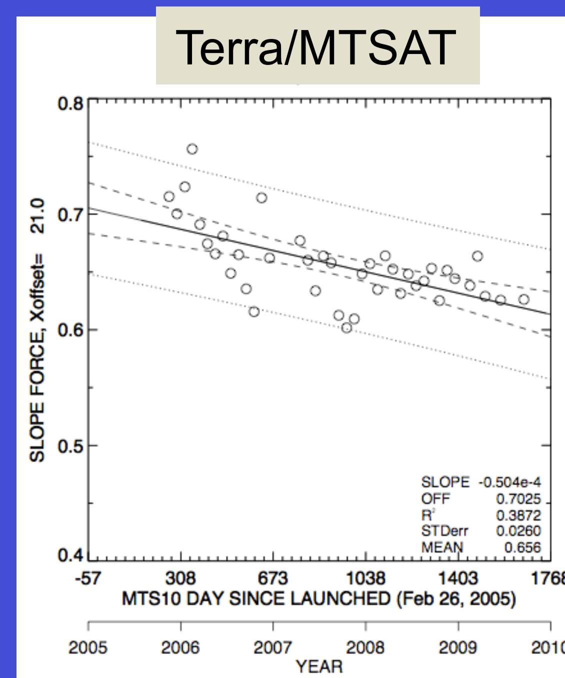


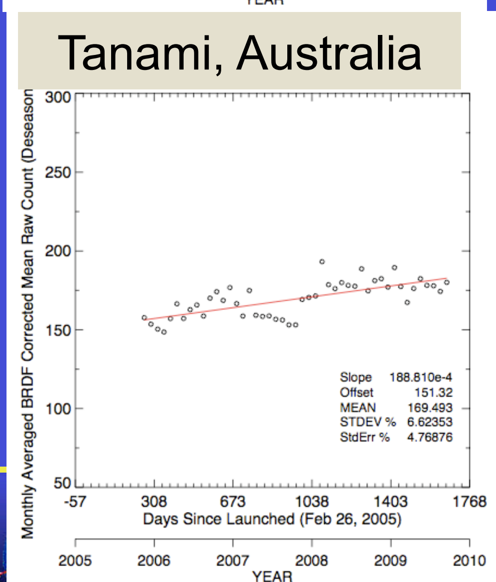


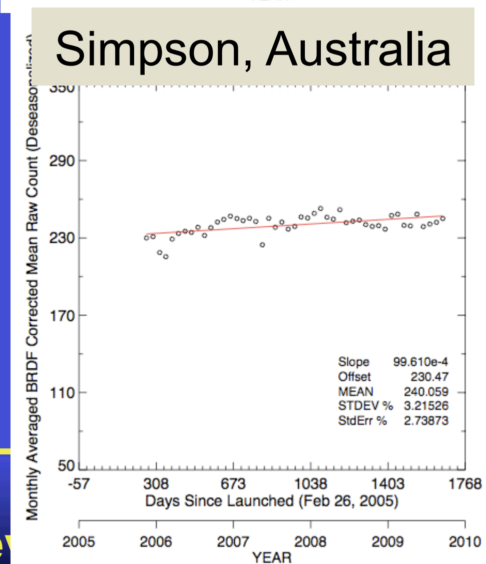
MTSAT gain increasing?









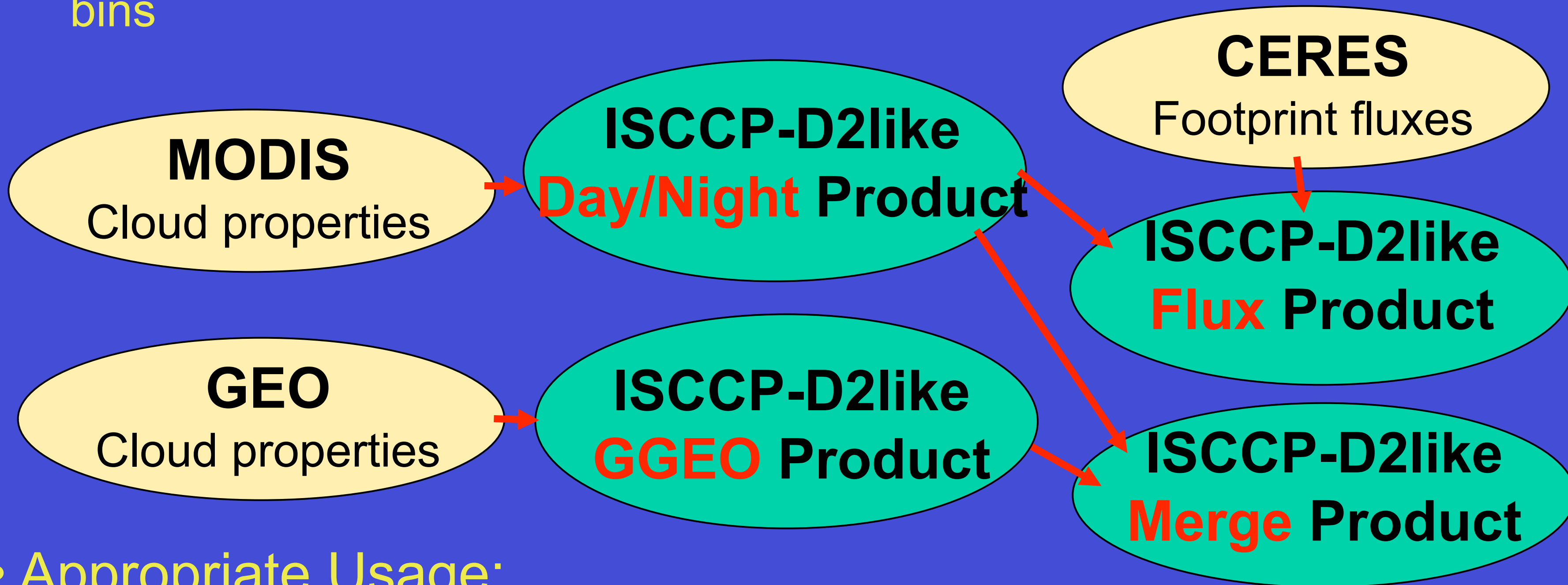


CERES ISCCP-D2like Products

M. Sun, C. Nguyen, M. Nordeen, R. Raju,
SSAI

ISCCP-D2like Product

- ISCCP-D2like Product Features:
  – Cloud properties are stratified by cloud top pressure and optical depth bins



- Appropriate Usage:
  – Monthly mean cloud properties product that emulates ISCCP D2 (NASA GISS) product to meet the needs of climate community.
  – ISCCP simulators in climate models

ISCCP-D2-like CERES Cloud types

Cloud top (mb)			
High 10-440	Cirrus liq=13,ice=16	Cirrus-stratus liq=14,ice=17	Deep Convective liq=15,ice=18
Mid 440-680	Alto-cumulus liq=7, ice=10	Alto-stratus liq=8, ice=11	Nimbo-stratus liq=9, ice=12
Low 1000-680	Cumulus liq=1, ice=4	Strato-cumulus liq=2, ice=5	Stratus liq=3, ice=6
Cloud optical depth	0.0-3.6	3.6-23	23-380
	Thin	Mid	Thick

- Stratify clouds in cloud pressure and optical depth bins
- CERES adds a liquid category to each of the high cloud bins
- CERES also adds a total cloud category

CERES ISCCP-D2-like Variables

Cloud Parameter	MODIS-only	GEO-only
Cloud Fraction	X	X
Effective Pressure	X	X
Effective Temperature	X	X
Optical Depth	X	X
Infrared Emissivity	X	
Particle size (radius, diameter)	X	
Liquid/Ice Water Path	X	X
# of days/GMT box	X	X

- CERES MODIS day/night also adds in IR emissivity, and liquid and ice particle size

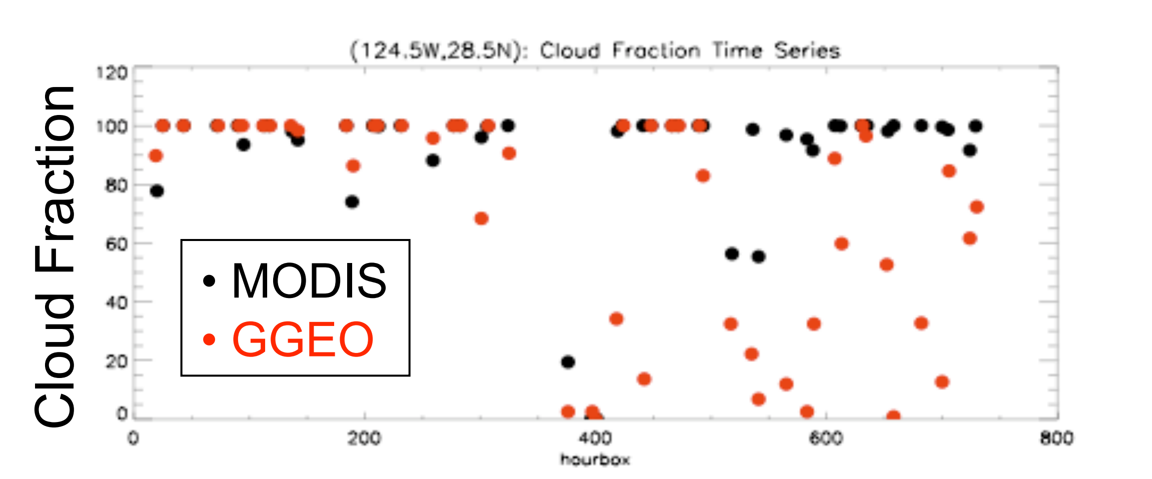
ISCCP D2-like Merged Product Development

- Combine MODIS and GGEO cloud properties to provide the user CERES best estimate of cloud properties.
  - Terra (10:30) and Aqua (1:30) have limited diurnal sampling on Sun-synchronous orbit. Twice daily for most of the regions by each satellites. MODIS cloud properties are superior to GEO
  - GGEO has 8 3-hourly observations per day but less accurate than MODIS cloud retrievals.
- Strategy:
  - Use MODIS cloud retrievals in the 3-hourly increment where they occur
  - Normalize GGEO cloud properties to MODIS in the remaining 3-hourly boxes, normalize day and night separately

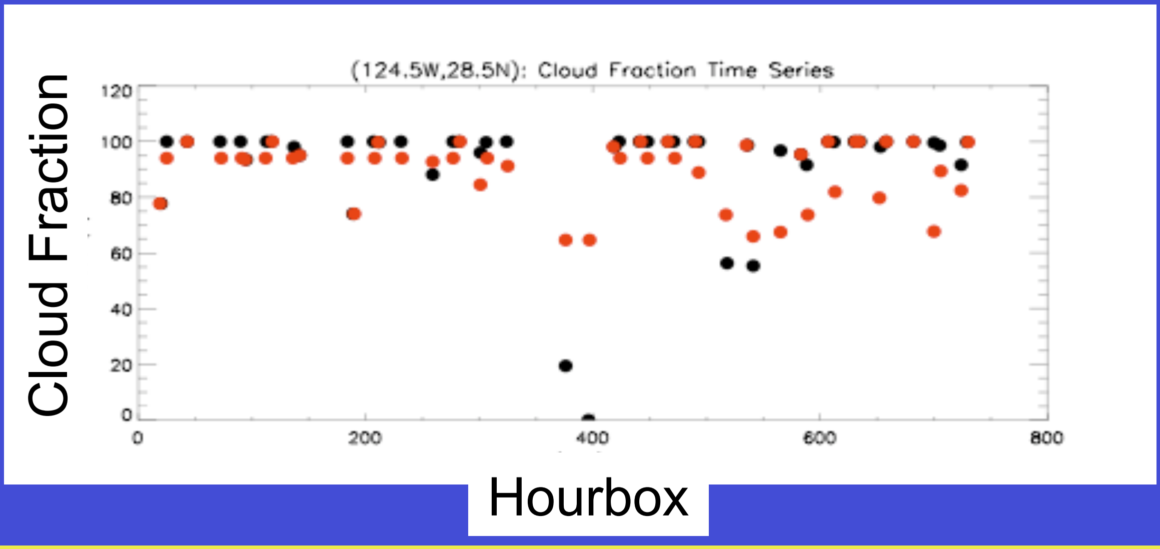
Cloud property normalization validation

- Use VIRS cloud retrievals as truth
  - VIRS has a 35° precessionary orbit, with a repeat cycle of 46 days, which cycles through all solar zenith angles in 23 days
- Strategy:
  - Derive normalization coefficients during Terra and Aqua (9-15 LT) overpass times between VIRS and GGEO
  - Apply coefficients during morning (6-9 LT) and afternoon (15-18 LT) GGEO cloud measurements
  - Compare GGEO normalized cloud properties with VIRS
- Normalization Algorithm
  - Linearly regress coincident within 1.5 hours all GGEO and VIRS cloud property measurements
  - Use all measurements within a 5° latitude by 5° longitude area that have the same geo-type as the given 1° region

Instantaneous Normalization Adjustment (124W, 28.5N)

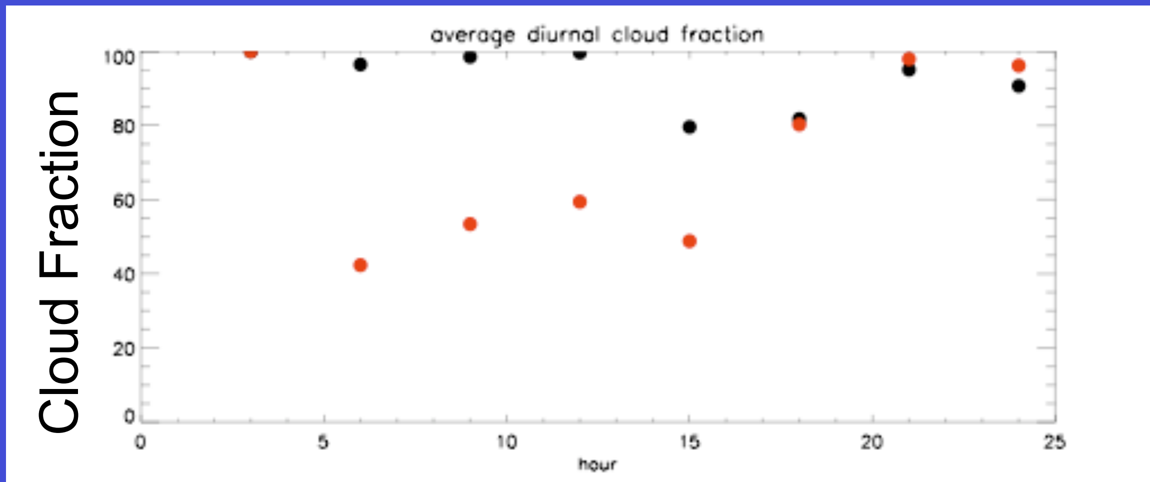


Before

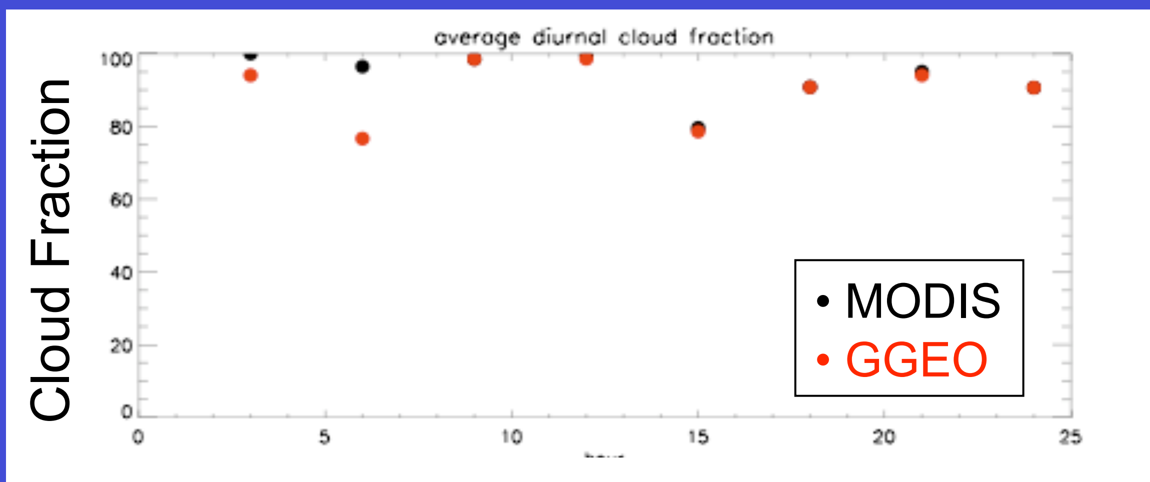


After

Monthly Hourly Cloud Diurnal Variation (124W, 28.5N)

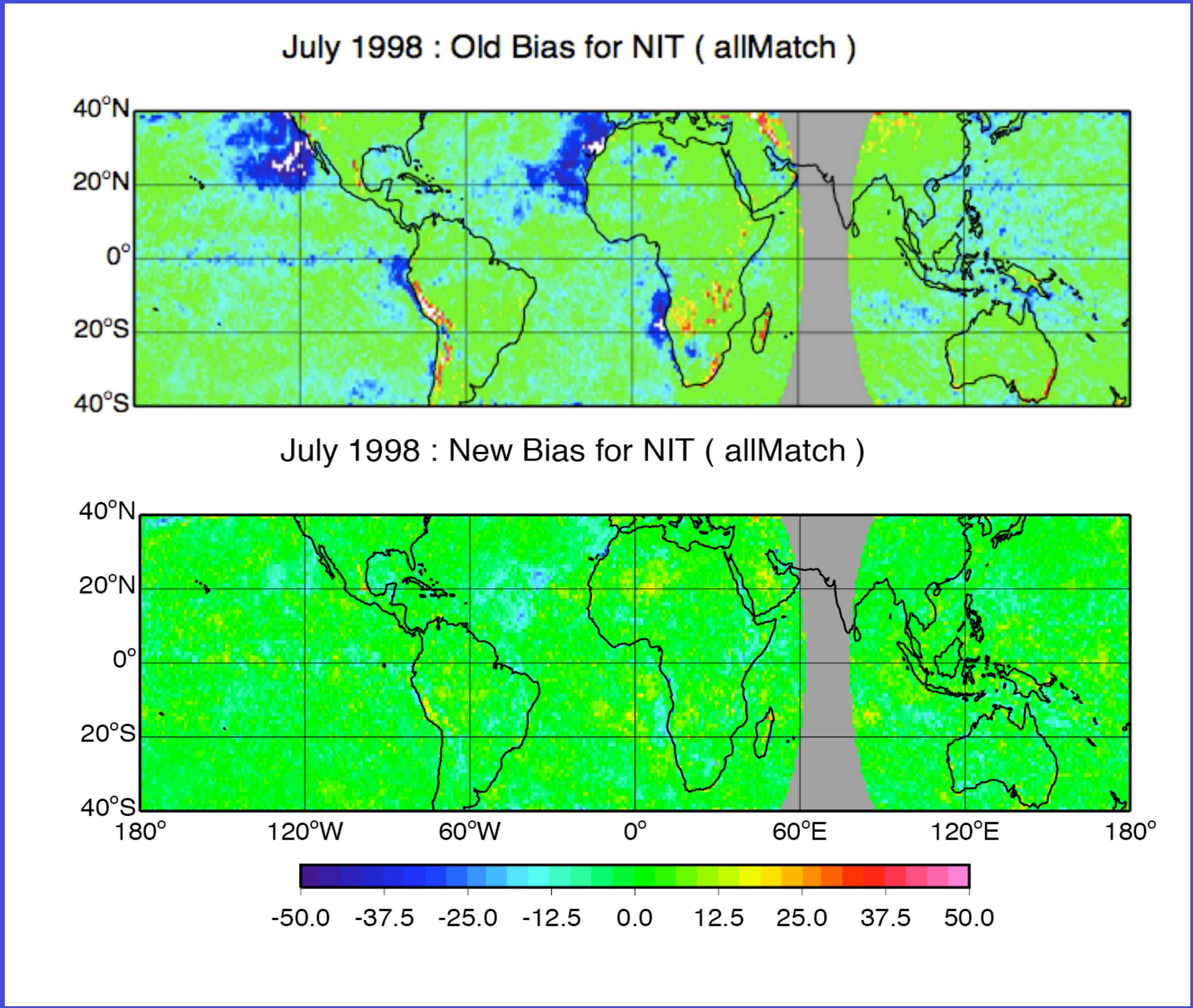


Before



Local Hour Box

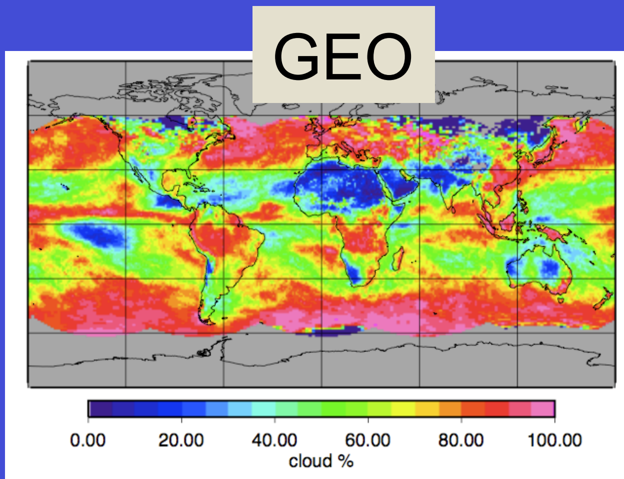
After

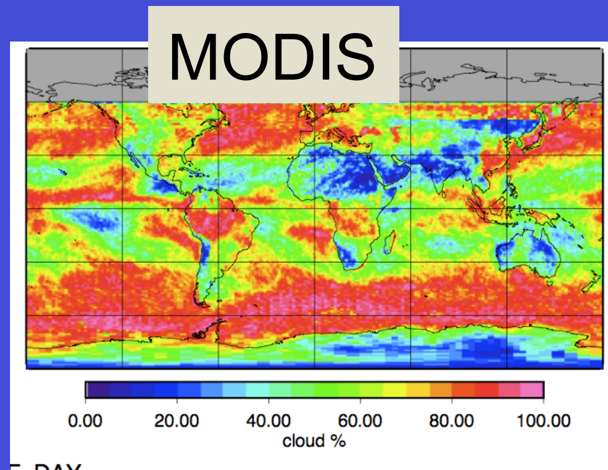

July 1998 : Old Bias for NIT (allMatch)
July 1998 : New Bias for NIT (allMatch)
40°N
20°N
0°
20°S
40°S
180°
120°W
60°W
0°
60°E
120°E
180°
-50.0
-37.5
-25.0
-12.5
0.0
12.5
25.0
37.5
50.0

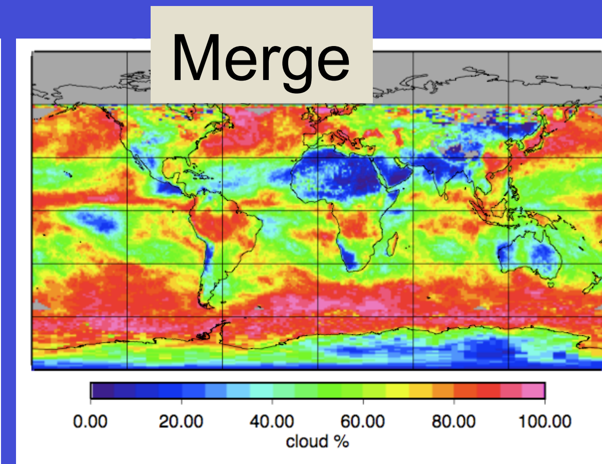
Terra/Aqua MODIS and GEO Normalization

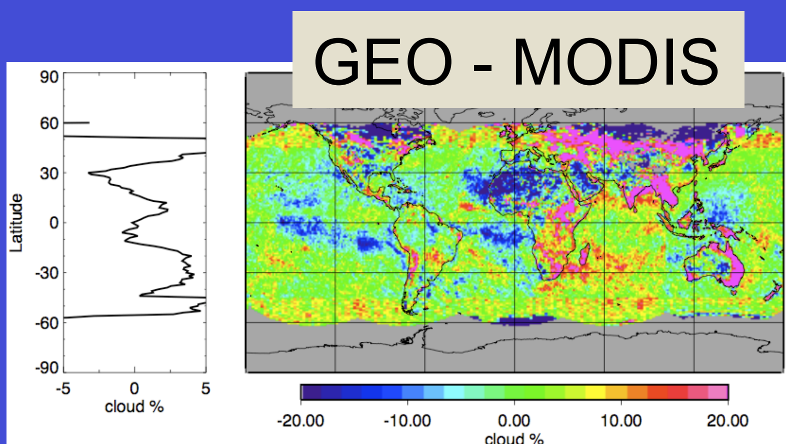
- Strategy:
  - Derive normalization coefficients during Terra (9-12 LT) overpass times with GGEO
  - Apply coefficients during morning (6-9 LT) and afternoon (12-18 LT) GGEO cloud measurements
- Normalization Algorithm
  - Linearly regress coincident within 1.5 hours all GGEO and Terra or Aqua cloud property measurements using 5° by 5° regions
  - Use VIRS/GGEO normalization methodology
- Validation:
  - Using Terra and GGEO coefficients during (9-12 LT) apply during Aqua overpass times (12-15 LT) and compare with Aqua measurements

Cloud Fraction, Dec 2002

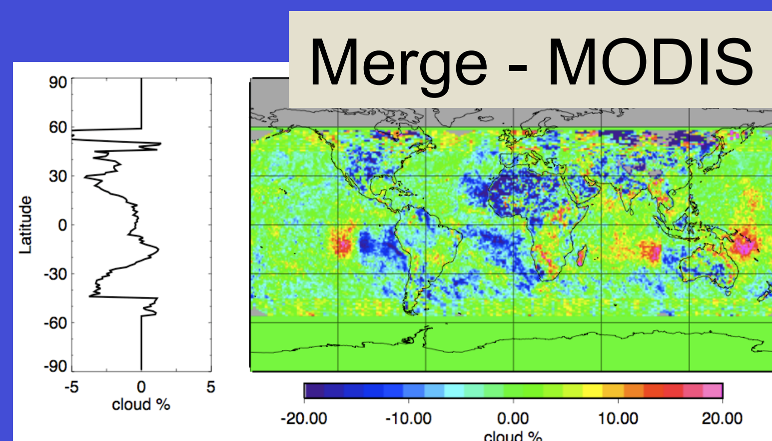






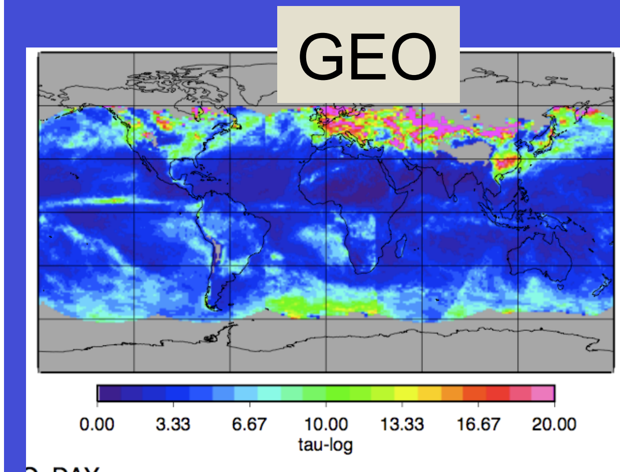


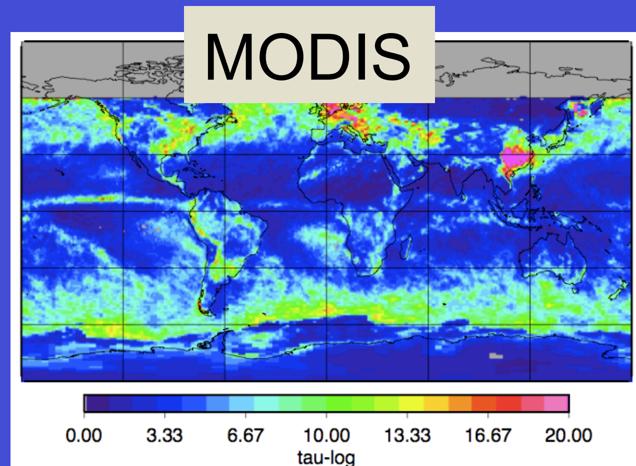
	GEO_DAY	SSF_DAY	BIAS
Global	64.35	59.60	4.76
60N-60S	64.29	63.42	0.87
30N-30S	57.49	56.66	0.82

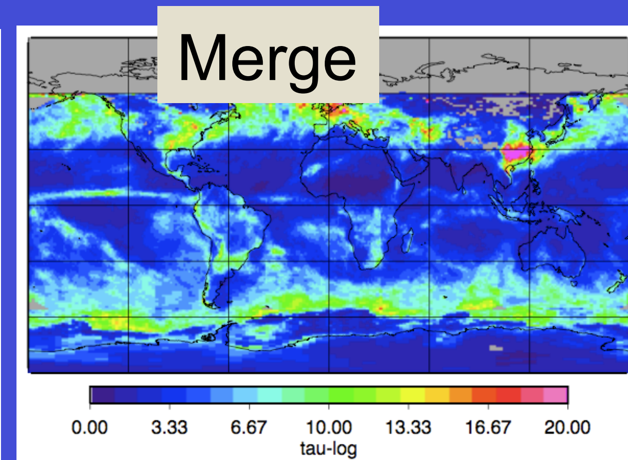


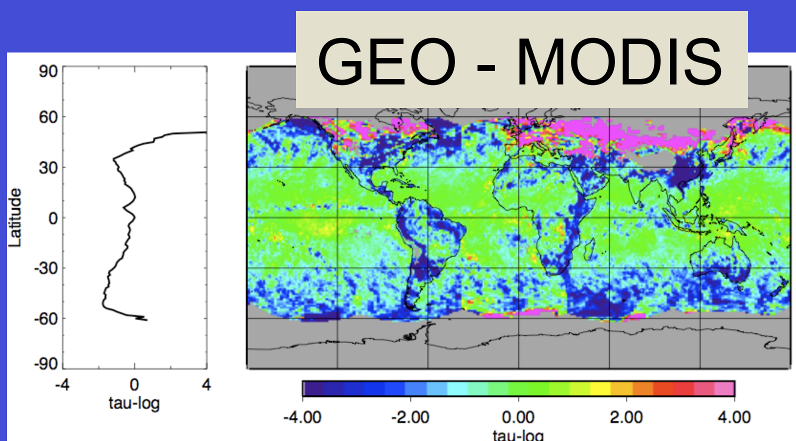
	Merge_DAY	SSF_DAY	BIAS
Global	58.47	59.60	-1.12
60N-60S	62.12	63.42	-1.30
30N-30S	55.79	56.66	-0.88

Cloud Optical Depth, Dec 2002

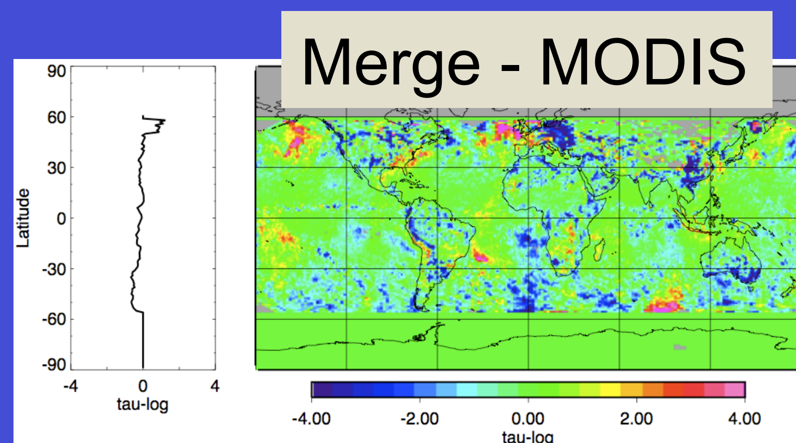






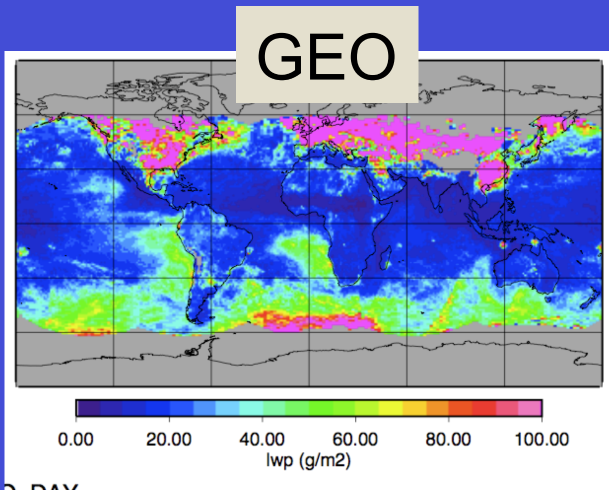


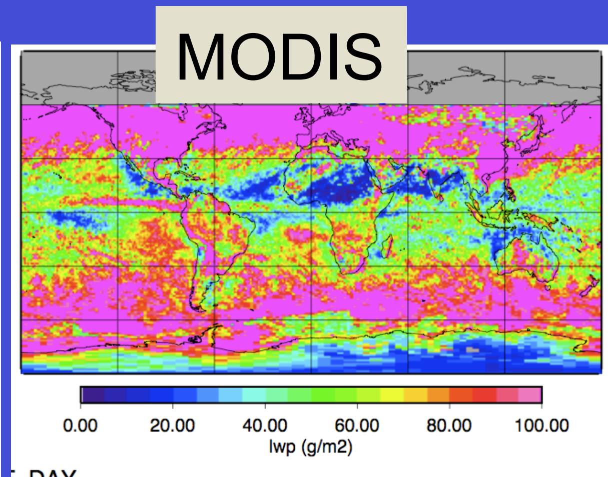
	GEO_DAY	SSF_DAY	BIAS
Global	4.21	4.69	-0.47
60N-60S	4.19	4.57	-0.38
30N-30S	3.02	3.41	-0.39

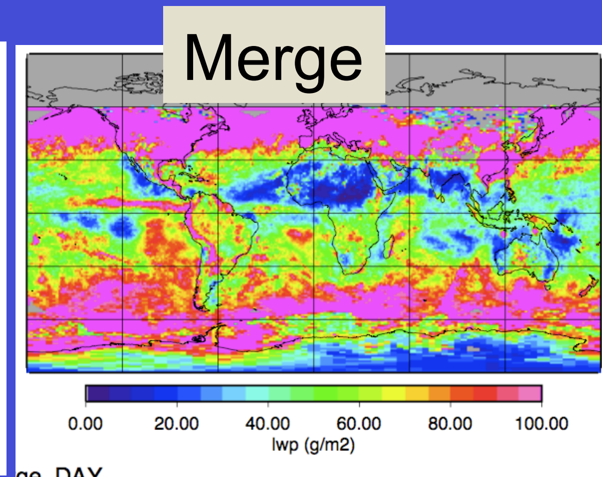


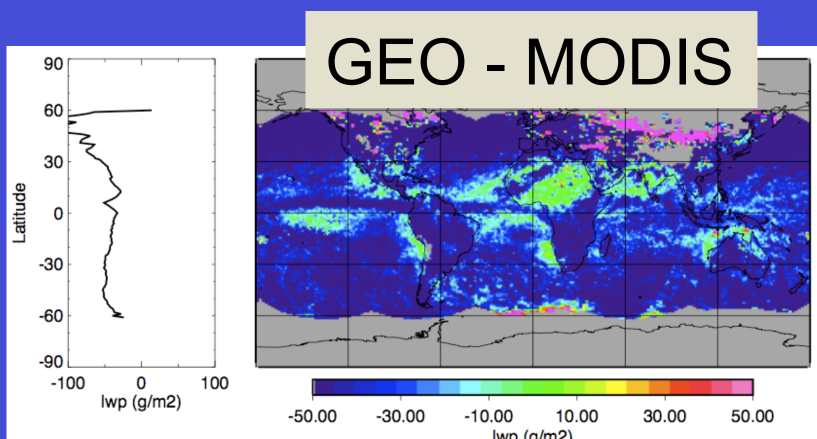
	Merge_DAY	SSF_DAY	BIAS
Global	4.40	4.42	-0.03
60N-60S	4.40	4.57	-0.17
30N-30S	3.24	3.41	-0.17

Daytime Cloud LWP, Dec 2002

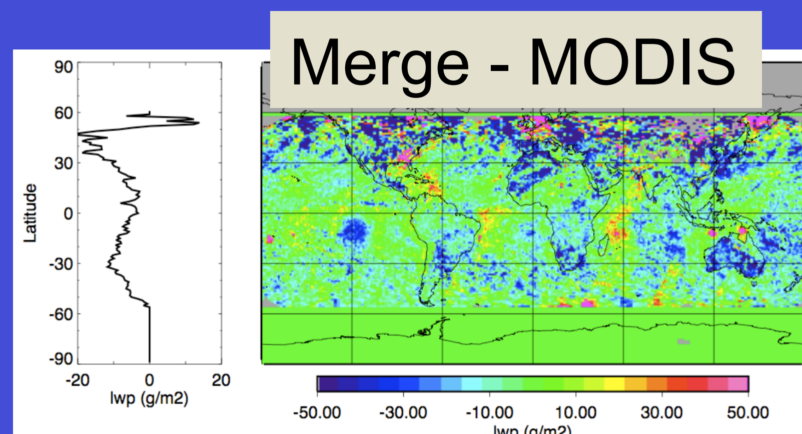








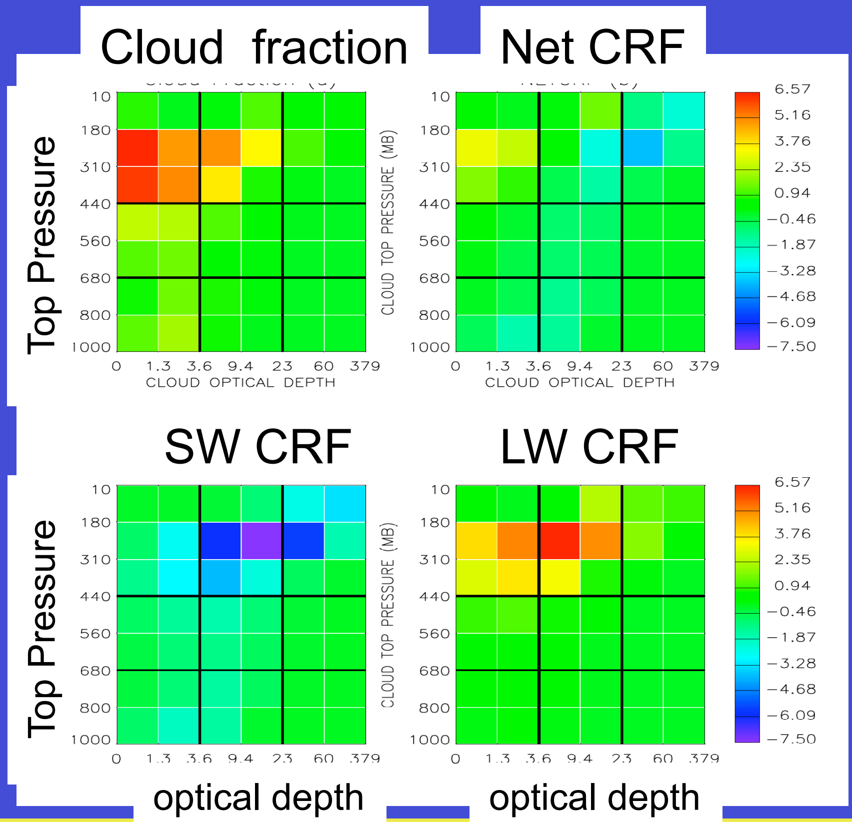
	GEO_DAY	SSF_DAY	BIAS
Global	40.11	91.77	-51.66
60N-60S	39.88	92.65	-52.77
30N-30S	21.02	62.27	-41.25



	Merge_DAY	SSF_DAY	BIAS
Global	84.92	91.77	-6.85
60N-60S	85.22	92.65	-7.43
30N-30S	55.43	62.27	-6.84

ISCCP D2-like Merged Product Development

- Develop ISCCP-D2like CERES flux product with associated D2 cloud types



Sun and Cess

ISCCP-D2-like 3-hourly Input

Index	1	2	3	4	5	6	7	8
GMT	00-03	03-06	06-09	09-12	12-15	15-18	18-21	21-24
Terra-day				X				
Terra-night								X
Aqua-day					X			
Aqua-night	X							
GEO			X	X	X	X		
Merge	A-nit	G	G	T-day	A-day	G	G	T-nit
Flux	A-nit			T-day	A-day			T-nit

ISCCP-D2-like Schedule

ISCCP-D2like	Ed2 Beta	Ed2 Edition	Ed3 Beta
MODIS day/night	• Delivered: Jul08 • Processed: Dec08 (Mar00-Aug07)	• Same version as Beta* • November 2009	• Absorb Ed3 cloud overlap properties • Spring 2011
GGEO	• Delivered: Mar08 • Processed: Jan09 (Mar00-Oct05)	• Same version as Beta* • November 2009	• Same version as Ed2 • Delivery: Spring 2011, After SYN
Merge	• Delivery: Feb10		• Same version as Ed2 • Delivery: Spring 2011, After SYN
Flux	• Delivery: Jul10 Add fluxes to MODIS day/night		• Add overlap clouds and fluxes • Delivery: Spring 2011

* Same read code for day/nit, GGEO and merge

TISA 6-month delivery goals

- Ed2C/F SYN/AVG/ZAVG Aqua and Terra processing complete (Mar00-Oct05)
- Ed2 GGEO calibration (Nov05-Dec07) extension, deliver Dec 2009
- SRBAVG Ed2E/F includes latest SOFA and daily means and RAPS normalization error (Mar00-Dec07), deliver Nov 2009
- ISCCP-D2like SSF day/night (Mar00-Dec07) and GGEO (Mar00-Oct05) Ed2 , deliver Nov 2009
- ISCCP-D2like-merge (Mar00-Oct05) Ed2 Beta, deliver Feb 2010
- ISCCP-D2like-flux (Mar00-Dec07) Ed2 Beta, deliver July 2010
- Ed2.5 SSF-grid-monthly-lite (Mar00-Dec08), deliver Dec 2010

- Ed3 Beta SSF-grid-hourly (SFC), deliver Dec 2009, Deliver Ed3 version 1 month after SSF
- Ed3 Beta SSF-grid-daily/monthly (SRBAVG nonGEO), deliver Dec 2010, deliver Ed3 version 1.5 month after SSF
- Ed3 Subsetter tool incremental deliveries, Nov 2009, Feb 2010, and May 2010

Edition 3 improvements

- Recalibrate all 11 GEO sensor to MODIS between Marc 2000 to 2009
  - Currently updated in ~ 2 year chunks
- GEO based clear-sky maps for cloud retrievals
  - Currently relying MODIS maps
- LW narrowband to broadband improvement
  - Currently simple global parameterization with column weighted RH
  - Use angular LW ADM strategy as was done in the SW
- GEO LW cubic spline temporal interpolation over land
- Ed3 Ordering Tool and subsetting improvements
- Ed3 schedule – to meet Terra senior review in 2011
  - Summer 2010 start processing SSF stream
  - Spring 2011 start processing SYN stream
  - CRS and SYN stream are decoupled, to allow parallel development